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P. Artedi. 6

ORDO

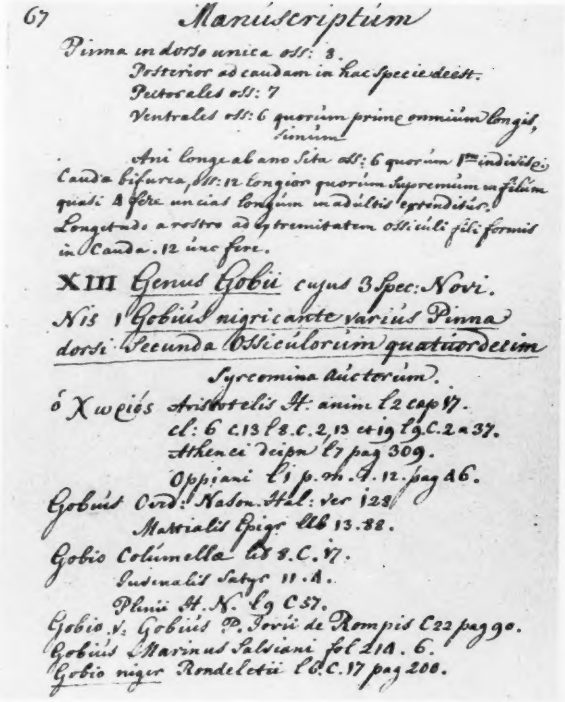
Piscium Centropterygiorum

seu

Quorum Ossicula in Pinna Dorsali imprimis Simplicia Sunt et plerumq; aculeata.

ob es möglich ist, so sollen diese mottey mit grossen Buchstaben zu setzen dass genus

Cyclopteri und Salistes Hasn.



67 Manuscriptum

Pinna in dorso unica ossi: 8.
Posterior ad caudam in hac specie deest.
Pectorales ossi: 7
Ventrales ossi: 6 quorum prime omnium longissimum
Ani longe ab ano Sita ossi: 6 quorum 1mus indivisus
Cauda bifurca, pin: 12 longior quorum superemum multum
quasi A fere uncias longum in duplis ostenditur.
Longitudo a rostro ad extremitatem ossiculi pisciformis
in Cauda. 12 unc fere.

XIII Genus Gobii cujus 3 Spec: Novi.

Nis 1 Gobius nigricante varius Pinna dorsi Secunda Ossiculorum quatuor decim

Synonima Auctorum.

ὁ Χωβιὸς Aristotelis H: anim l 2 cap 17.
cl: 6 c 13 l 8 c 2, 13 et 19 l 9 c 2 a 37.
Athenei Deipn l 7 pag 309.
Oppiani l 1 p. m. H. 12. pag 16.
Gobius Ovid: Halieut: ver 128
Martialis Epigr lib 13. 88.
Gobio Columella lib 8. c. 17.
Iuvenalis Satyr 11. A.
Plinii H. N. l 9 c 57.
Gobio v. Gobius P. Jovii de Rempis c 22 pag 90.
Gobius Marinus Salviani fol 214. b.
Gobio niger Rondeletii l 6 c. 17 pag 200.

Plate I. Pages 6 and 67 from Artedi's *Manuscriptum Ichthyologicum.*

# A Rare Manuscript Adding to our Knowledge of the Work of Peter Artedi

By Daniel Merriman

THE name of Peter Artedi (1705-1735) is well known among ichthyologists, for it is associated with the man who made the most outstanding contributions to the system of classification of fishes in his time. However, sources of information about Artedi and his work are all too scarce, and most of the material that has been preserved is to be found in his *Ichthyologia*. This was published in 1738 at Leyden through the efforts of Linnaeus, who, after much difficulty and expense, had acquired Artedi's manuscripts following the latter's death. It is considered particularly valuable as the best example of Artedi's work, and it also contains an eleven-page introduction by Linnaeus dealing with the life of its author. Lönnberg's (1905) and Merriman's (1938) papers on Peter Artedi, and such brief accounts as that given by Günther (1880) and Nordenskiöld (1928) are based mainly on the *Ichthyologia* and its *Vita Authoris*.

Another and much less important piece of Artedi's work is a manuscript dated February 24, 1729, "A Short List of the Trees, Bushes, and Plants that are Indigenous to the Glebe-Lands in Nordmaling and the Villages lying in its Immediate Vicinity." This original manuscript still exists in the Upsala University Library, and was published in 1905 on the 200th anniversary of Artedi's birth. It is of considerable historical interest since it shows plainly the influence of the celebrated botanist, Tournefort, and records the Nordmaling flora of the time.

The only other published work of Artedi is in the third volume of the *Sebae Thesaurus*. This was the study on which Artedi was engaged in the last two and a half months of his life in 1735, and which he had not completed at the time of his death. Shortly after Artedi drowned, Albertus Seba died, and his heirs (particularly B. Seba) undertook to finish the description of his zoölogical collection, which resulted in the eventual publication of the third volume of the *Sebae Thesaurus* in 1758. This contains, among other things, twelve large plates with nearly 150 engravings of fishes and the accompanying descriptions of them. As Lönnberg has indicated, it is not easy to tell for which of these descriptions (the plates were done by a number of different engravers) Artedi is responsible, although B. Seba says in his introduction that Artedi did many of them—

> Ista autem hujus operis pars, quae de piscibus agit, tanto carior esse Ichthyophilis debet, qui per constantes characteres diversa horum animalium genera ac species, systematice, quod dicunt, ordinare ac distinguere amant, quia celeberrimo illi piscium Scrutatori, ARTEDIO, tantum non omnes, quae hic prostant, piscium descriptiones debeantur. Summus ille Ichthyologus propemodum universam piscium Musei Sebani historiam consecerat, quum sera nocte ab aedibus B. Seba domum suam reversurus, per tenebras forte aberrans, in quandam hujus urbis fossarum delaberetur, misereque aquis demersus, magno Auctoris nostri damno ac dolore, vitam finiret.

There are, however, indications in the text and from the style of the de-

scriptions themselves as to which were done by Artedi and which by others after his death (see below).

There has recently come to the attention of the present writer an unusual manuscript[1] which sheds considerable light on the work of Peter Artedi during July, August, and September, 1735—the period during which he was employed by Seba up to his untimely death. This manuscript is entitled *Manuscriptum Ichthyologicum quod Petrus Artedi elaboravit in Usum Thesauri Sebani* (ichthyological manuscript which Peter Artedi compiled for the use of Seba's collection). It has a full leather binding, with gold-tooled covers and raised bands on the spine. It measures 9¾ by 7½ inches, is 85 pages long, and is in excellent condition. A note on the front fly-leaf indicates that it is a manuscript copy made by one Rob. Wilh. van Homrigh, and given away by him in 1773. Various other notes on the fly-leaf show that this manuscript eventually came to the hand of Richard Heber (probably at the Henry P. Hope sale of February 18, 1813), and that it was bought from him in a lot of 400 rare books at Sotheby, May 30, 1836, by Sir Thomas Phillipps[2] for two shillings. It became listed among the accessions of the library of the Bureau of Fisheries on August 15, 1899, and has remained in that library ever since.

This manuscript is apparently a copy of the original notes made by Peter Artedi on Seba's collection. It therefore affords a direct clue as to exactly what part of the work in the *Sebae Thesaurus,* Vol. III, is Artedi's. The bulk of the writing is in Latin, but there are several interesting comments in German, as well as occasional Greek words throughout the text. Most of the hand is clear, and makes easy reading, although certain foot-notes and some parts of the descriptions of the fishes are more difficult. On the whole, the copyist appears to have done an accurate and complete job, with the exception of the consistent misspelling (save in the title) of the name "Artedi" at the top of each page (see Plate I, "P. Altedi" on page 6), and several errors in pagination. For the most part the fishes of each genus are listed in order together, but in some instances the sequence is broken and various inserts are made later in the manuscript. This probably indicates either that Artedi's original notes were out of order at the time they were copied, or that Artedi, after completing the work on one genus, and having progressed to other genera, eventually came on additional species which he wished to assign to the first genus.

The manuscript is particularly interesting because it contains many comments and notes that are not included in Volume III of the *Sebae Thesaurus.* Thus the *Thesaurus* gives only a few indications of the localities in which any of the fishes which are described were collected. The *Manuscriptum Ichthyologicum,* on the other hand, contains an introductory statement to the effect that this is:

> An ichthyological treatise describing more than a hundred of the principal fishes of Amboina and Surinam, which are arranged according to the natural method, with their

[1] The author wishes to express his appreciation to Mr. Don Bloch, Informational Service Representative of the Fish and Wildlife Service, U.S. Department of the Interior, for calling his attention to this manuscript and making it available for study, and for obtaining permission to reproduce the pages from it shown in Plate I. He is also grateful to Mr. James T. Rabb, Mr. Frank E. Brown, and others, of Yale University, for their assistance in the translation and interpretation of the manuscript.

[2] Phillipps MS. 8328.

distinct genera and new specific differences, and with the principal synonyms used by authors in previous descriptions.

That the fishes in Seba's collection should have come from Amboina and Surinam is not surprising since both places were in Dutch colonies—Amboina, in the Molucca or Spice Islands in Dutch East India, and Surinam in Dutch Guiana in the northeastern part of South America. It does not appear, however, that *all* the fishes listed in the *Manuscriptum Ichthyologicum* came from these localities; for example, the account of the only species described in the genus *Cyclopterus* ("Lumpus Anglorum") terminates with the following statement: "Oceanus Britannicus, Germanicus, Mar: Balthicum, etc:".

In the *Sebae Thesaurus* the fishes are grouped in different genera, which appear in much the same order as they do in the *Manuscriptum Ichthyologicum*. Each species is given a number which refers to one of the engravings on one of the twelve plates. The engravings composing any one plate usually consist of the members of several genera, but the resultant groupings apparently do not indicate an attempt to place related genera in maniples—the families of a later date. Rather, it seems obvious that the different fishes on any one plate were determined by the space at the engraver's disposal. In the *Manuscriptum Ichthyologicum*, however, there is clear indication that Artedi intended to classify Seba's fishes in larger categories than genera. This is exemplified by the note in German at the bottom of page 6 (see Plate I), which states that, "If it is possible, these words must be printed with capital letters between the genus Cyclopterus and Balistes." The words to which Artedi refers are, of course, "Ordo Piscium Centropterygiorum," a group of fishes "whose ossicles in the dorsal fin are primarily simple and for the most part spinous." It is curious that there is no reference to centropterygian fishes in Artedi's *Ichthyologia* as published by Linnaeus in 1738. Actually the genera *Balistes* and *Cyclopterus*, along with *Ostracion* and *Lophius*, constitute Ordo III, BRANCHIOSTEGI, in the *Ichthyologia;* there is no indication that the *Balistes* group can be separated from the *Cyclopterus* group by anything more than generic differences. Since the *Manuscriptum Ichthyologicum* certainly represents the last work Artedi did, one wonders whether the *Ichthyologia* is actually Artedi's own classification or a Linnaean modification of it.

The main genera listed in the *Manuscriptum Ichthyologicum* are as follows (in the order they appear):

Ostracion
Cyclopterus
Balistes—"cujus VI Species novi"
Chaetodontis
Echeneidis
Holocentri
Pentameni
Scombri
Perca—"cujus XIII Sp: novi"
Cotti—"cujus VII Species Novi"
Mysti—"cujus 10 Species novi
Plecostomi—"cujus 4 Sp: Novi"
Gobii—"cujus 3 Spec: Novi"
Blennii
Labri—"cujus 7 Sp: Novi"

The species under each genus are numbered according to the accompanying plate on which each was to appear. There are slightly less than one hundred different species in the entire manuscript. The emphasis on genera in the *Manuscriptum* is characteristic of the Artedian method, and, as has been pointed out before (Merriman, 1938), shows the influence of Tournefort on his work. The polynomial system of nomenclature is used throughout.

It is well known that Artedi's species and genus characterizations were models of accuracy and exactitude, and the *Manuscriptum* is an excellent example of this. The dorsal and anal fin-ray counts (both soft and spinous) are regularly given, and not infrequently the counts on pectoral, ventral, and even caudal fins are listed. The shape of the body, head, and caudal fin appears commonly, as do comments on the "superior" and "inferior" maxillaries (the maxillary and premaxillary bones). The type of dentition is at times mentioned, and the scales and general color are often described. Probably the most complete description in the entire manuscript is of the genus *Holocentri*; this is the only instance in which Artedi refers to the internal anatomy of a fish. The account contains a section headed *Partes Intestinae,* which includes such comments as: "Liver divided into two lobes, of which the left is the larger," "ventricle not large," etc. And finally, at the conclusion of the list of characters for the members of this genus, there is an N.B. in German to the effect that, "The scales of this fish are so beautiful and marvellous that they can be engraved on copper." This was probably intended as a suggestion to the engraver that a sketch of a typical scale be included in the plate on which this fish was to appear. That the hint was apparently not taken is evident from the fact that no scales are shown on this or any other plate.

Artedi's complete familiarity with the available ichthyological literature is shown in the *Manuscriptum* by the full lists of the synonyms of previous authors in various parts of the text. This is well exemplified under the first species described in the Genus *Gobii* on page 67 as shown in Plate I.

Finally, it is apparent from a comparison of the *Manuscriptum Ichthyologicum* and Volume III of the *Sebae Thesaurus* that Artedi described approximately two-thirds of the fishes included in the latter. All the species in the *Manuscriptum* appear to be included in the *Thesaurus,* but some of the species in Artedi's part of the *Thesaurus* are not in the *Manuscriptum*—e.g., the many species of *Ostracion.* It seems clear that after Artedi's death the descriptions of many of the interesting fishes in Seba's collection were finished by someone else (probably B. Seba); plates were also made to accompany these accounts. Among the forms included in this latter section of the part on fishes in the *Thesaurus* are *Anableps,* the four-eyed fish, *Gymnotus,* the electric eel, *Squalus, Acipenser,* etc. The plate including *Anableps* and *Gymnotus* is shown in Plate II, and is noteworthy in that it is certainly one of the earliest descriptions of the four-eyed fish and the structure of its unusual eye. That Artedi did much of the work on *Anableps* is acknowledged in the text, and the priority of his studies on this fish over those of Gronovius is also indicated. The account of the eye is surprisingly complete, as is illustrated by the engravings shown in Plate II.

For the most part, however, the written accounts of the fishes in the

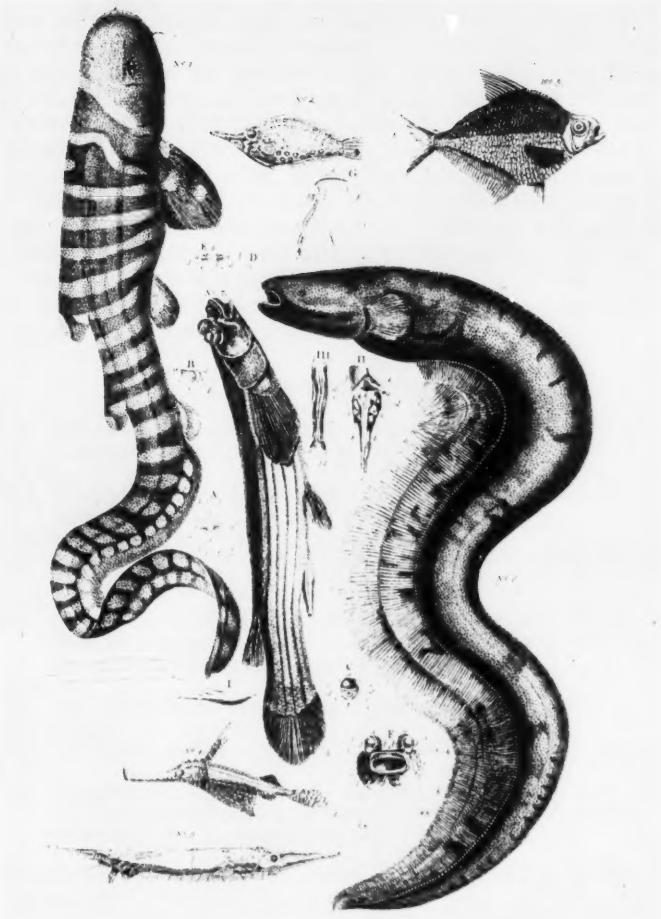


Plate II. Plate XXXIV from the *Scbae Thesaurus*, including *Anableps* (No. 7), *Gymnotus* (No. 6), as well as *Squalus* (No. 1), *Balistes* (No. 2), *Tetragonoptrus* (No. 3), *Solenostomus* (No. 4), and *Amphisilen* (No. 5).

part of the *Thesaurus* completed after Artedi's death form a distinct contrast to the precise anatomical observations and comments that characterize the Artedian work throughout. Here the descriptions tend to degenerate into accounts of the wonders of the color pattern, and to the use of superlatives in an attempt to portray the beauties of the different forms. Morphological characters, on the whole, are given less emphasis, and despite the model of Artedi's work, which must have been before the individual who completed the account of Seba's collection, there is a reversion to the methods of description that are typical of this period. There can, in conclusion, be little doubt that in this respect Artedi was far ahead of his time, and that, as Günther (1880) put it, "—he establishes the method and principles which subsequently have guided every systematic ichthyologist." Indeed, Gill (1874) was fully justified in regarding Artedi as the father of modern ichthyology, who "—introduced a precise terminology, full and pertinent diagnoses, and throughout uninomial generic names."

## Literature Cited

Artedi, P.
1738 Ichthyologia sive opera omnia de Piscibus (edited by Linnaeus), Lugduni Batavorum, Apud Conradum Wishoff.

Gill, T. N.
1874 Arrangements of the families of fishes, or classes Pisces, Marsipobranchii, and Leptocardii. *Smithson. Misc. Coll.*, 11 (No. 247), 1872: 27–28.

Günther, A. C. L. G.
1880 An introduction to the study of fishes. Adam and Charles Black, Edinburgh: 8–10.

Lönnberg, E.
1905 Peter Artedi—A bicentenary memoir written on behalf of the Swedish Royal Academy of Science (translated by W. E. Harlock). Uppsala and Stockholm, Almquist and Wiksells Boktryckeri—A.–B.: 1–44.

Merriman, D.
1938 Peter Artedi—systematist and ichthyologist. Copeia, 1: 33–39.

Nordenskiöld, E.
1935 The history of biology—a survey. Tudor Publishing Co., N.Y.: 209–210.

Seba, A.
1758 Locupletissimi rerum naturalium thesauri accurata descriptio et iconibus artificiosissimis expressio per universam physices historiam. Vol. III. Amstelaedami, apud Janssonio-Waesbergios.

Osborn Zoölogical Laboratory, Yale University, New Haven, Connecticut.

# Notes on Age Determination and Growth of the Atlantic Bluefin Tuna, *Thunnus thynnus* (Linnaeus)

By J. R. Westman and P. W. Gilbert

THE increasing importance of the bluefin tuna as an Atlantic game fish has within recent years aroused considerable interest and speculation concerning the species' life history and taxonomy. Information concerning the rate of growth of Atlantic tuna is quite fragmentary. The statements of Yarrell (1836: 135) on the size of tuna during the first few months after hatching are widely quoted; but the rate of growth, based on scale readings, has remained a mystery owing probably to a difficulty in obtaining readable scales. Corson (1923: 108) examined the scales of a "53-inch" tuna weighing 100 pounds, taken in the vicinity of Fire Island, New York. He noted that the scales from the "shoulder" were not readable, but that scales from the "hind portion appear to indicate fifth year of age." A 29-inch tuna which Corson examined "appeared to be in the second year of its life."

## Source of Material

During the summer and fall of 1938, while engaged in work with the New York State Biological Survey, the writers had an opportunity to collect scales and length measurements from 100 tuna taken by angling gear and ocean pound nets in the waters off the south shore of Long Island.[1]

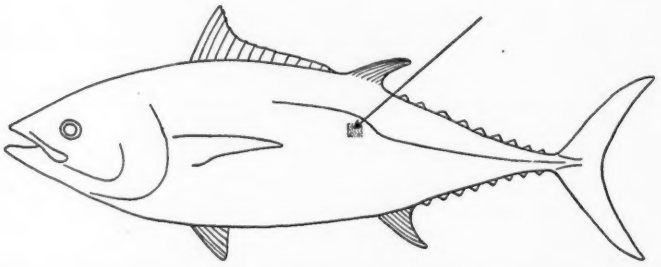


Fig. 1. Outline drawing of bluefin tuna showing area (arrow) where scales were taken for age determination.

A preliminary study of several fish indicated that scales procured from the small area on the side indicated in Fig. 1 were suitable for reading. The scales in this region vary, however, in both size and opacity, so that considerable care must be exercised in taking only those which are small, thin and transparent. The impression method of preparing the scales was found

[1] The writers wish to acknowledge their indebtedness to Dr. Emmeline Moore, Director of the New York State Biological Survey, for permission to use these data. Appreciation is also extended to the following: Mr. W. C. Neville of the U. S. Bureau of Fisheries and Mr. C. L. Dickinson, for their cooperation in securing material; Mr. A. H. Underhill of Cornell University, for his assistance with the reading of scales.

to be the most satisfactory, particularly when fish exceeded 40 inches in length. The length measurements were taken to the nearest half-inch, from snout to fork of tail.

### Size Composition of the Samples

The lengths of fish sampled from commercial and angling catches during the month of August, 1938, are presented by their frequency of occurrence in Fig. 2. While sampling was done with no attempt toward the selection of particular fish, circumstances prevented taking the steps necessary to assure a completely random sample. The sample as presented, therefore, is not necessarily representative of the catch. In like manner the catch itself may not be representative of the population from which the fish were taken since fishing gear can also be selective to an unknown degree. The length-frequencies do reveal, however, the general size range of those fish taken by angling and commercial gear during August, 1938.

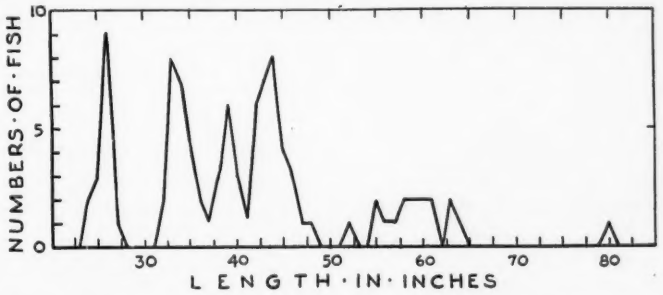



Fig. 2. Length-frequency distribution of the 100 tuna sampled from commercial and angling catches made during August, 1938.

Approximately one-half of the fish represented in Fig. 2 were taken by anglers and of this number only four exceeded 44 inches in length. These smaller fish are known to the anglers as "school tuna" and are generally taken by trolling methods, a procedure which is much less effective with the larger bluefin.

### Age-Length Relationships

Age determination of fish by scale reading must frequently rest on the assumption that the "checks" or "annuli" are true indicators of age. This criterion has been used in the present instance and may receive some support from the fact that the first two modes of the length-frequency curve appear to represent one and two-year-old fish respectively. The annuli on tuna scales were found to be clearly defined in fish less than five years old (Plate I) but were more difficult to read in older specimens.

The age-length relationships, based on 85 obtainable scale readings, are presented in Fig. 3 by a method similar to that used by Westman and Fahy (1939: 230). Not included in this graph are two fish taken in 1939, the first a 91-inch specimen taken in the ocean pound nets off Fire Island, New York and the second a 14-inch tuna captured by angling gear in the vicinity

of Brielle, New Jersey, on September 2, 1939. The former weighed 345 pounds and appeared to be in its fourteenth year of growth while the latter, weighing one pound twelve ounces, was apparently a young of the year.

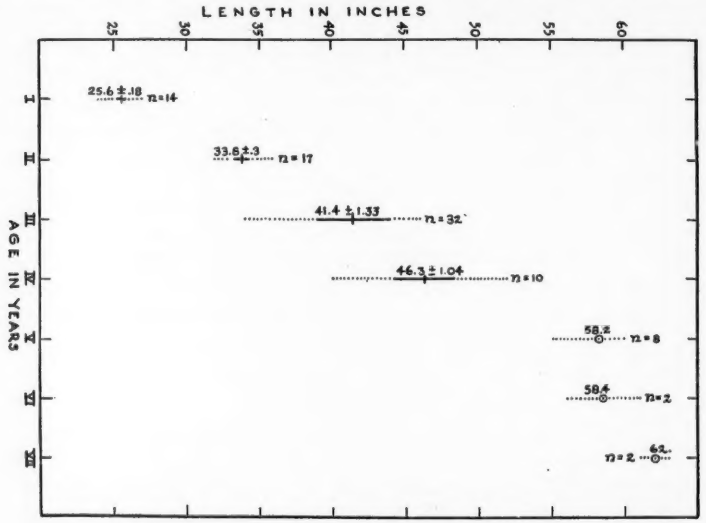



Fig. 3. Age-length relationships of 85 tuna sampled from the commercial and angling catches made during August, 1938. The dotted lines represent the limits of variation for specimens of each year class. The solid line is twice the standard error of the mean in both the plus and minus directions. The numbers of specimens in each year class and the means with standard errors are also given.

Of possible interest is the fact that when the length-frequency distributions of angling and commercial samples were plotted separately or collectively, the three-year-old specimens produced a bimodal curve. If such a curve were present in a representative sample, sexual dimorphism or separate races might be considered as a possible cause. In this respect it has been noted by Herrington (1938: 4) that possibly two or more species of bluefin tuna are present in the waters of the north Atlantic. Adequate sampling will throw some much needed light on this subject.

## Literature Cited

Corson, R. H.
1923 Fire Island fish notes. Copeia (123): 108.
Herrington, W. C.
1938 *U. S. Bureau of Fisheries, Fisheries Service Bulletin*, 1938 (October): 4.
Westman, J. R. and W. E. Fahy
1940 The carp problem of the area. *In* "A Biological Survey of the Lake Ontario Watershed," *Suppl. 29th Ann. Rept. N. Y. Cons. Dept.*, 1939: 226–231.
Yarrell, W.
1836 A history of British fishes. London, Vol. 1: 134–139.

Cornell University, Ithaca, New York.

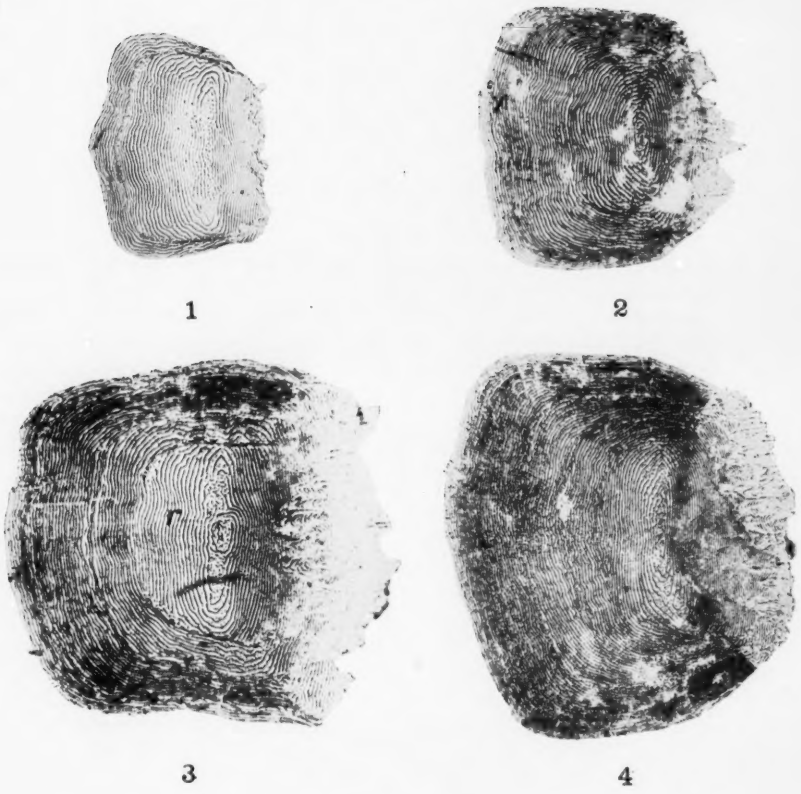



Plate I. Bluefin tuna scales from one (1) to four (4) years of age.

# *Cephalurus*, a New Genus of Scyliorhinid Shark With Redescription of the Genotype, *Catulus cephalus* Gilbert

By Henry B. Bigelow and W. C. Schroeder

As Garman long ago pointed out (Mem. M.C.Z., 36, 1913; 38), the systematic relationships of the little deep-water scyliorhinid *Catulus cephalus* Gilbert, have been doubtful, lacking information as to its dentition, labial folds, nasal flaps, eyes, etc. We therefore welcomed the opportunity, afforded through the courtesy of Dr. George Myers, of examining a paratype, leading to the conclusion that it can not be referred to any extant genus.

To begin with, the fact that its first dorsal originates considerably in front of its pelvics sets it apart from all other undoubted scyliorhinids. True, it agrees in this with *Proscyllium*, but in the latter the first dorsal terminates in front of the pelvics, instead of over or behind them, showing it actually to be a triakid, not a scyliorhinid. It is further separated from *Scyliorhinus* (to which Garman tentatively referred it) by the fact that the labial furrow extends around the corners of the mouth. The rear contours of the dorsals of *cephalus*—straight or even slightly concave from base to apex—are also unique for this family. We therefore propose for it the new genus *Cephalurus*.

***Cephalurus*, gen. nov.**

Genotype, *Catulus cephalus*, Gilbert, Proc. U. S. Nat. Mus., 14, 1891: 541.

Scyliorhinidae, with base of first dorsal originating considerably in front of origin of pelvics and terminating over rear end of base of latter; rear outlines of dorsals and of anal straight or even slightly concave from base to apex; infero-basal contour of caudal evenly rounded, not produced; inner margins of ventrals of male confluent, beyond vent, for about one-third their lengths; pectorals quadrate, with bases about as wide as distal margins; head very broad, relative to body rearward from pectorals, obtusely rounded anteriorly, with very short snout; nostrils entirely separated from mouth, and far apart; anterior nasal flaps moderately lobed, but without definite barbel; mouth obtusely rounded, its length about one-third its breadth; upper lip closing inside lower near corners; a labial furrow around corner of mouth and extending forward for a short distance on lower jaw; upper and lower teeth essentially similar, with acute triangular median cusps and 1–3 lateral denticles on each side; eye oval, its anterior margin about opposite symphysis of upper jaw; spiracle oval, behind eye; gill slits short, fourth over pectoral origin, their anterior margins deeply concave; dermal denticles thornlike to lanceolate.

*Cephalurus cephalus* Gilbert

*Catulus cephalus*, Gilbert, Proc. U. S. Nat. Mus., 14, 1891: 541; Jordan and Evermann, Bull. U. S. Nat. Mus. 49, 1896; 24; Garman, Mem. Mus. Comp. Zool., 36, 1913: 78.
*Scyliorhinus cephalus*, Regan, Ann. Mag. Nat. Hist., Ser. 8, 1, 1908: 460.

Description of a paratype, 186 mm. long, male, Stanford University Museum, No. 293; from Gulf of California, "Albatross" sta. 3007.

Proportions, in percentages of total length (186 mm.): height of trunk at pectoral origin 6.5; breadth of trunk at pectoral origin 14.5; interorbital breadth 6.5; snout to eye 6.5, to mouth 5.9, to origin of first dorsal 48.0, to origin of second dorsal 57.0, to origin of upper caudal 71.5, to origin of pectoral 26.6, to origin of ventrals 44.5, to origin of anal 55.8; horizontal diameter of eye 3.8; breadth of mouth 13.4; height of mouth 4.8; breadth between nostrils 2.4; length of upper labial fold 0.8, of lower labial fold 1.9; width of first gill slit 4; of 5th gill slit 2.7; pectoral outer margin 10.8; inner margin 7.8; distal margin 7.5; length of first dorsal base 9.1; interspace first dorsal to second dorsal 9.4; length of second dorsal base 8.1; interspace second dorsal to caudal 8.1; length of upper caudal 28.5; length of lower caudal 29; length of anal base 8.6; interspace anal to caudal 4.8. Trunk (fig. 1)

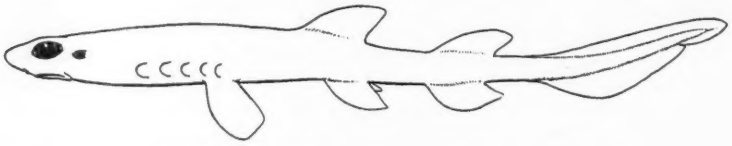


Fig. 1. Paratype, 186 mm. in total length.

very slender, posterior to pectorals, its height at first dorsal about 7% of its total length; caudal penduncle laterally compressed, its height at origin of caudal slighly more than twice its breadth, without lateral keels or precaudal pit above or below; caudal axis only slightly raised; body sector of trunk about as long as tail sector; anterior part of trunk greatly expanded laterally, its breadth about 16% of total length at origin of pectorals, and about 20% opposite corners of mouth; anterior outline of head broadly rounded (fig. 2);

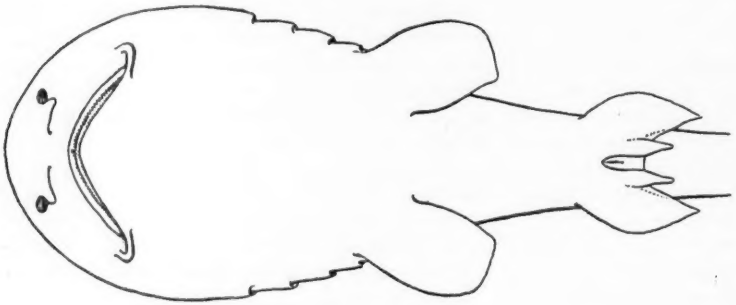


Fig. 2. Ventral view of specimen shown in fig. 1.

snout very short, see above proportions; nostrils entirely separate from mouth, their inner angles about one-half as far from latter as from tip of

snout; anterior nasal flaps with prominent lobes; mouth obtusely arcuate, occupying slightly more than one-half the breadth of head; a well-marked labial fold around corner of mouth, extending a very short distance forward on upper jaw and about twice as far on lower (fig. 2); upper lip closing within lower at corner of mouth; teeth widely spaced in 2-3 functional rows; anterior teeth largest, with long erect axial cusp flanked basally by two (occasionally three) short lateral cusps on outer and one on inner margin; outermost teeth smaller, with relatively shorter axial cusp; lower teeth similar to upper, but those near symphysis with axial cusps more or less curved outward, and those near corners of mouth nearly evenly 4-5 cuspidate (fig. 3);

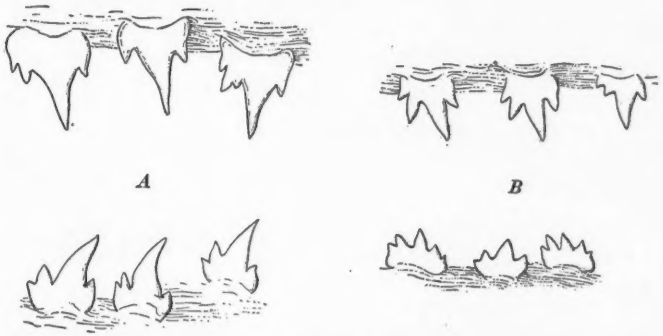



Fig. 3. Upper and lower teeth; × about 30: A) near symphysis; B) near corner of mouth.

eyes, oval, noticeably large, horizontal diameter equal to about one-fourth the distance from tip of snout to first gill slit; no trace of subocular folds; spiracle broadly oval, prominent, its diameter nearly one-half the horizontal diameter of eye, situated behind latter by a distance slightly greater than its own diameter; gill slits (fig. 1) short, lateral, their anterior margins deeply concave, first to third longest and about equal, fourth and fifth slightly shorter, spaces between first and second and between second and third about 1½ times as wide as between fourth and fifth, fourth over origin of pectoral and fifth considerably behind latter; first dorsal originating anterior to origin of ventrals by a distance nearly one-half as long as its own base, and terminating basally a short distance in front of termination of base of ventrals, subtriangular, rounded apically, with strongly convex anterior and straight posterior margin, its posterobasal corner not produced; second dorsal similar to first except slightly lower relatively, and about as long basally, its origin about over that of anal; anal about as large as second dorsal, subquadrate, with broadly rounded apical and acute posterior corner; caudal with well-marked sub-terminal notch, its terminal sector acute-ovate, its lower contour rounded without antero-basal lobe; interspace between caudal and anal about ⅔–¾ as long as base of latter; ventrals intermediate in shape between dorsals and anal, their inner margins united, in male, for about one-third their lengths; pectoral quadrate, about 1.5 times as long as broad, outer margin

strongly convex, inner and distal margins nearly straight, outer corner broadly rounded but inner more angular, base broader than length of distal margin; dermal denticles (fig. 4) widely spaced on trunk, erect; chiefly thorn-like on upper surface of head and on sides of trunk (fig. 4, C) but occasionally interspersed with narrow lanceolate denticles, the latter increasing in frequency up the sides; most of those along the dorsal surface of trunk from origin of first dorsal rearwards, still broader, and weakly tridentate, with sharp apices, though not ridged (fig. 4, A); denticles most closely spaced (often overlapping), broadest, and most markedly tridentate along upper edge of caudal (fig. 4, E).

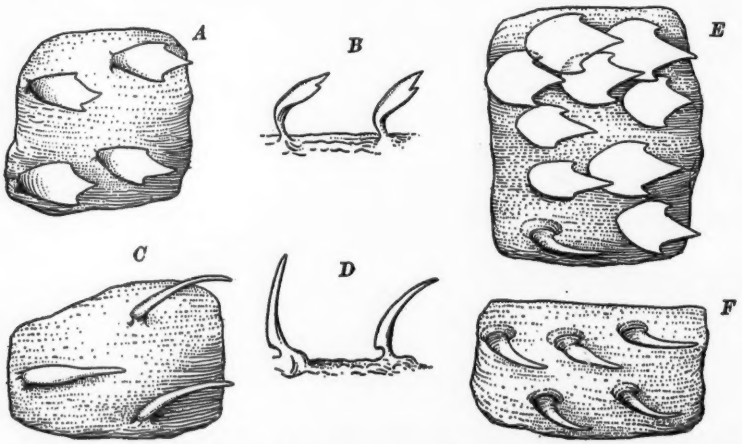



Fig. 4. Dermal denticles; × about 40. A) from back, close in front of first dorsal, top view; B) same, side view; C) from side, close below first dorsal, top view; D) same, side view; E) from side of caudal, close to upper margin; F) from side of caudal near mid-level.

Color.—Uniform brown above and below, by the original account (Gilbert, 1891).

Range.—The original—and only recorded—captures were off the Revillagigedo Islands and in the Gulf of California in 460 and 362 fathoms.

Museum of Comparative Zoology, Cambridge, Massachusetts.

# Digit Bias in Measuring and a Device to Overcome It

By Oscar E. Sette

WHENEVER measurements are made by comparing the position of the boundary of an object with a graduated scale, as in measuring fish, even with the aid of pointers or cross hairs, there is a tendency, differing with observers, to favor certain digits. With trained observers carefully using good instruments, this bias should be slight. In the vast majority of instances where the results of groups of measurements are reduced to averages, it is of no consequence. Where the measurements are assembled into frequency distributions it may introduce artificial irregularities which may be bothersome when significance is to be attached to the shape of the curve. The irregularities can be reduced and sometimes obliterated by appropriate grouping into class intervals, or by mathematical smoothing. But when the frequency distribution is to be compared to theoretical curves by critical statistical methods such as the chi square test, such bias-induced irregularities form a serious, if not insurmountable, obstacle.

This became obvious in my work on a series of tens of thousands of measurements of the Pacific sardine, or pilchard, *Sardinops caerulea,* accumulated over a period of years by a number of observers of the California Division of Fish and Game, and kindly loaned to the United States Fish and Wildlife Service for a special analysis involving curve fitting. These measurements had been made carefully by trained observers with the aid of a measuring board equipped with a sliding rider which could be placed so that its cross hair or thread would be over the point to be measured on the fish, running from there to a point over a rule which was graduated in millimeters, and the readings were made to the nearest millimeter. The length of the fish ranged from 150 to 300 mm. When the measurements were grouped according to observer and classified according to the final digit of the reading, it was apparent that each person had a different bias pattern. Some of these are shown in fig. 1. An example of odd-even bias is given by A. The probabilty (P), computed by the chi square method, that purely random variations would exceed the observed variations from the mean, is 0.002. A case of bias in favor of five and zero and against four and seven is given by B ($P = <0.001$). The three C curves were of measurements by the same observer and grouped by time periods. During the first two months, C, there was a marked bias favoring zero and five mainly at the expense of one, four, six, and nine ($P = <0.001$). At the end of this time the observer must have noted its existence, and attempted to avoid it, for the third month, C′ ($P = <0.001$), exhibits the opposite of the former bias with respect to zero and five. Apparently noting this also, the observer again changed his habits during the succeeding three months, C″ ($P = <0.001$), practically eliminating bias as concerns zero and five, though retaining significant bias, now favoring three and eight mainly at the expense of four and seven.

Such biases can be eliminated by incorporating in the measuring mechanism a mechanical selector. The one devised for the sardine measuring board

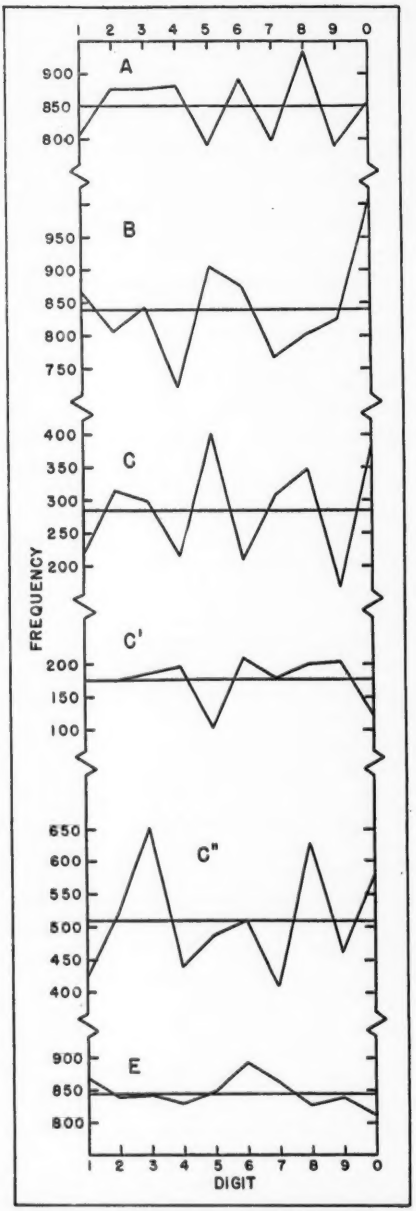


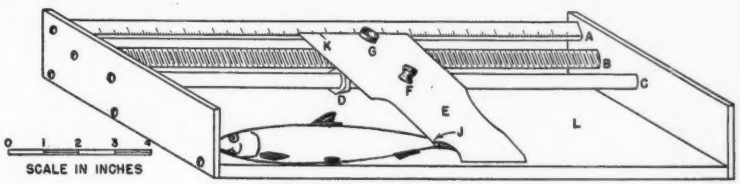

Fig. 1. Frequencies of final digits in length measurements of sardines. For each curve the mean frequency is indicated by the horizontal line.

(fig. 2) consists of a 300 mm. screw-threaded rod (B) running lengthwise of the board, the threads of which were cut so as to be exactly 1 mm. from ridge to ridge. On the underside of the sliding rider (E) there is a quarter of a nut (H) threaded to fit this screw. The rider teeters on its rod (C) so that in one position it is free from the screw and can be slid to the point to be measured. Then it can be teetered to the other position where the nut engages with the screw. As it engages, the rider moves the fraction of the millimeter necessary to bring it to the position where the rider reference mark (K) will point to the *nearest* millimeter on the graduated scale (A).

The base of the board (L) was made of non-warping bakelite and the metal parts of corrosion-resistant hard bronze. The thread edges on screw and nut were hardened by chromium plating. It is convenient to install the screw so that by rotating, it may be adjusted so as to correspond exactly to the millimeter graduated rule, and then be locked into fixed position.

A number of such measuring boards have been in use by the California Division of Fish and Game and by the United States Fish and Wildlife Service for several seasons, and have proved not only to correct the bias fault, (see E; $P = 0.76$) but also have relieved the users of the eyestrain and nervous tension that attended the former selection, by eye, of the nearest millimeter.

It has been found that in 5.4 percent of the readings, when the rider is almost precisely at the half-millimeter position, the nut threads straddle the screw threads, and the rider does not readily teeter down. For such instances the next lowest millimeter is recorded with a plus mark following the entry. At a later time, alternate plus-marked entries are thrown to the next highest millimeter, thus preserving the perfect balance in the treatment of border-line readings. The percentage of straddlings could be reduced, if not elminated, by substituting a knife edge for the quarter nut. It might be difficult, however, to maintain an unmutilated edge.




A- MM. SCALE.
B- MM. THREADED ROD.
C- RIDER ROD.
D- SLIDING SLEEVE.
E- SLIDING RIDER.
F- SLIDING RIDER KNOB.
G- DEPRESSING BUTTON.
H- QUARTER NUT.
J- POINTER.
K- REFERENCE MARK.
L- BASE.

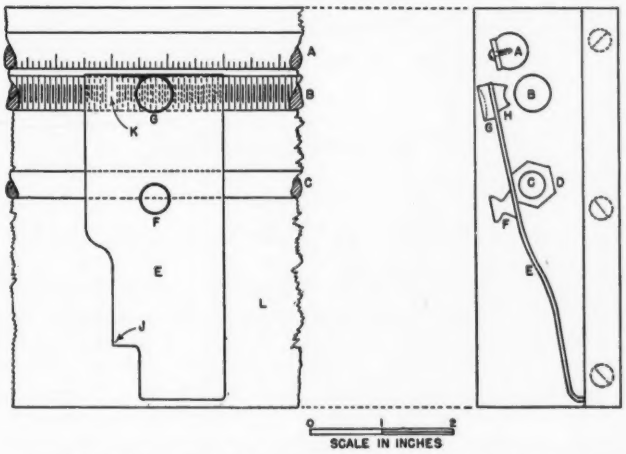



Fig. 2. Above, isometric sketch of entire measuring board. The scale graduations are drawn twice, and the screw threads are spaced quadruple, the scale of the rest.
Below, left, plan view of sliding rider in relation to board. Both the screw threads and graduations of the scale are twice the scale of the rest.
Below, right, side view of sliding rider in relation to board.

In measuring larger fish where coarser units, such as centimeters or half-centimeters, are customarily used, a bar with upper edge serrated could be

substituted for the screw, and a triangular member fitting the serrations substituted for the quarter nut. With this arrangement, the scope of teetering movement of the rider would have to be increased accordingly.

UNITED STATES FISH AND WILDLIFE SERVICE, JORDAN HALL, STANFORD UNIVERSITY, CALIFORNIA.

# Fluctuations in the Diet of the Chinook and Silver Salmons (*Oncorhynchus tschawytscha* and *O. kisutch*) off Washington, as Related to the Troll Catch of Salmon [1]

By RALPH P. SILLIMAN

## INTRODUCTION

THE catch of salmon, like that of many other species, is subject to large fluctuations, both within and between seasons. Fishermen and conservationists desire to know the causes of these fluctuations: the former so that they may plan their operations in advance; the latter to enable them to design satisfactory conservation measures. Fluctuations in the catch of the troll or hook and line fishery for the chinook and silver salmons (*Oncorhynchus tschawytscha* and *O. kisutch*) have a close relationship to fluctuations in the diet of the two species. The reason for this is found in the method of fishing.

The salmon are caught by means of towing through the water, at low

1 Examination of stomach contents of salmon, presented in this paper, was undertaken as a branch of the pilchard investigation of the United States Fish and Wildlife Service to determine whether the population of pilchards is present in Pacific Northwest waters at times when the commercial fishery is not in operation. Too few pilchards were secured in this way to provide conclusive evidence, but the information on diet of salmon appears sufficiently significant to warrant publication.

The writer is grateful to Dr. Willis A. Rich and Mr. Vernon E. Brock of the Oregon Fish Commission, who furnished valuable information regarding the salmon fisheries. The cooperation of the following fishermen in supplying samples is appreciated: Fred C. Elfers, Chris Ness, Charles Wuori, Charles F. Erickson, and John J. Ostervold. The State of Washington Department of Fisheries supplied records used in some of the statistical analyses. Mr. O. E. Sette and Dr. L. A. Walford of the United States Fish and Wildlife Service gave freely of their time for advice, suggestions, and criticism.

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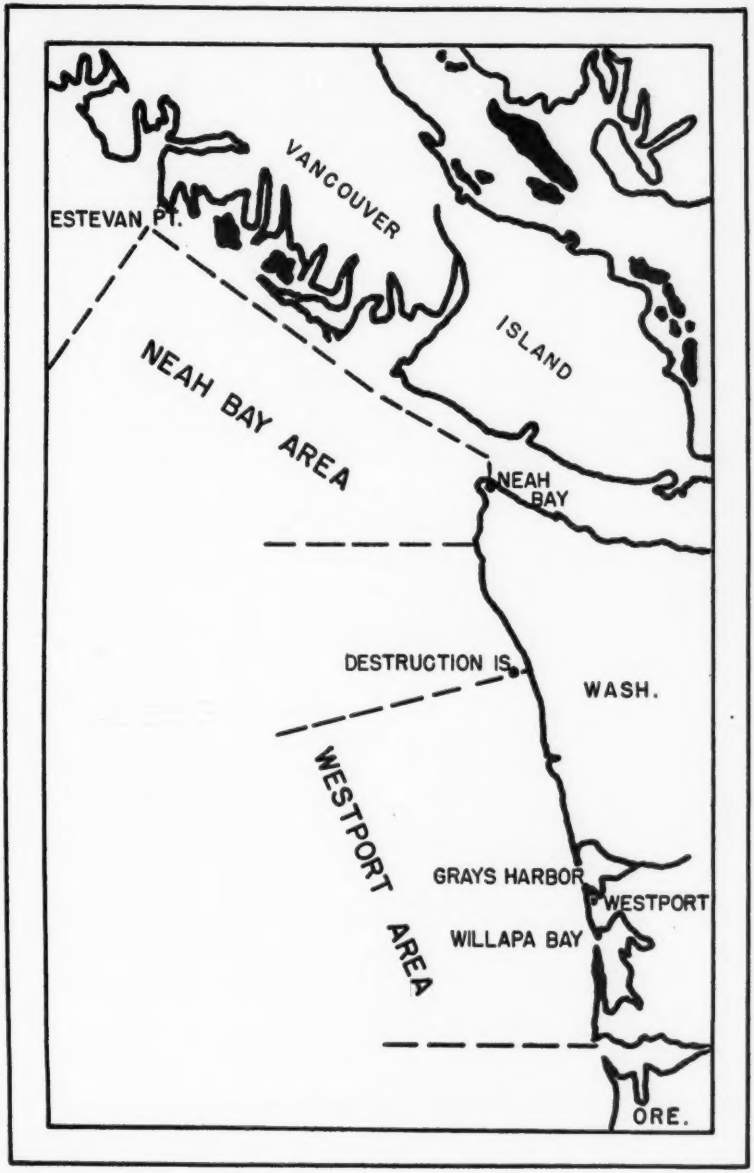


Fig. 1. Fishing areas from which samples of salmon stomachs were taken, 1938.

speed, pieces of shiny metal designed to simulate swimming, wounded small fish such as salmon normally eat, like herring, pilchards, etc. Hooks are attached to these lures, resulting in the capture of any salmon which strike at them. Occasionally the fish themselves are used as lures. Thus fluctuations in catch are not necessarily due to changes in the concentrations of salmon in the fishing areas, but may result from changes in feeding habits. The material presented in this paper is designed to indicate the relationship between salmon diet and catch off the coast of Washington.

## Methods

To obtain samples of the stomach contents of the two species, five-gallon cans (containing a 4% formalin solution) were left with each of several troll fishermen, who were instructed to place in these containers digestive tracts from all salmon caught. The tracts were separated as to species by means of the pyloric coeca, which average 140 to 150 for chinooks, and 50 to 80 for silvers (Schultz, 1936). Each tract was slit open as far back as the pylorus, and the contents were identified, enumerated, and weighed. Weights were recorded to the nearest gram, and stomachs containing .5 gram or less were listed as empty.

Food organisms were classified according to the following categories: pilchard, *Sardinops caerulea;* herring, *Clupea palassii;* smelt, *Osmerus* sp.; anchovy, *Engraulis mordax;* rockfish, *Sebastodes* sp.; miscellaneous fish, all other species, including mainly *Ammodytes tobianus personatus, Podothecus acipenserinus, Anaplopoma fimbria,* and various pleuronectids; euphausids; crab larva, *Cancer* sp.; and miscellaneous invertebrates, all other species, chiefly copepods, amphipods, isopods, cephalopods, and gastropods.

## Period and Area Covered

Samples were collected from two fishing regions; the Neah Bay area, extending roughly from Estevan Point, Vancouver Island, to Ozette Island, off the coast of Washington, and the Westport area, including that portion of the coastal waters lying between Destruction Island, Washington, and the Columbia River (fig. 1). From the Westport area samples were taken about weekly from April to November, 1938. At Neah Bay, sampling was much less thorough, with most of the samples being taken during July and August. In all, 1369 stomachs were taken in the Westport area, and 317 at Neah Bay (Tables 1, 2, 3, and 4). Each sample represents the stomachs preserved by fishermen with whom containers were left during one to thirty-one days, the periods averaging ten days. The dates indicated in all tables and graphs represent the median of these periods (except where the exact date was known). In the statistical analyses to follow, the samples have been grouped in half-month periods according to their median date. Periods during which less than 12 stomachs were collected have been omitted.

## Types of Organisms Eaten

The organisms found in the stomachs of the chinook and silver salmons during the period under study may be separated into two categories: fish and invertebrates. In the former classification the chief species were pilchards,

TABLE 1
AVERAGE CONTENT OF CHINOOK SALMON STOMACHS FROM THE WESTPORT AREA, 1938, GRAMS PER STOMACH

| Period | *Number of Stomachs | Type of Food Organism: Pilchard | Herring | Smelt | Anchovy | Rockfish | Miscellaneous Fish | Unidentifiable Fish | Euphausid | Crab Larva |
|---|---|---|---|---|---|---|---|---|---|---|
| Apr. 1–15 | 75 | .6 | ... | ... | 27.9 | ... | ... | 14.2 | ... | ... |
| Apr. 16–30 | 27 | ... | ... | ... | 3.1 | ... | ... | 1.9 | ... | ... |
| May 16–31 | 57 | ... | 1.4 | ... | ... | ... | .1 | .6 | 60.6 | 1.0 |
| June 1–15 | 64 | ... | .9 | .5 | ... | ... | ... | .5 | 39.4 | ... |
| June 16–30 | 89 | ... | .4 | .5 | .1 | .1 | 1.0 | .7 | 20.1 | .1 |
| July 1–15 | 102 | ... | 4.8 | .4 | ... | ... | ... | 2.2 | 5.0 | ... |
| July 16–31 | 59 | 3.1 | 4.3 | 4.7 | 1.2 | 1.4 | 1.3 | 2.9 | 1.9 | ... |
| Aug. 1–15 | 32 | .8 | ... | 1.3 | ... | 4.9 | ... | 6.2 | 1.0 | ... |
| Aug. 16–31 | 75 | 2.4 | 4.4 | .1 | ... | ... | ... | 2.9 | .4 | ... |
| Sep. 1–15 | 47 | 1.6 | 1.1 | .4 | 1.5 | ... | 1.2 | 2.3 | .... | ... |
| Sep. 16–30 | 12 | ... | ... | ... | ... | ... | .5 | .4 | .... | ... |
| Oct. 1–17 | 20 | ... | ... | ... | ... | ... | ... | .1 | .... | ... |

* Includes empty stomachs.

TABLE 2
AVERAGE CONTENT OF SILVER SALMON STOMACHS FROM THE WESTPORT AREA, 1938, GRAMS PER STOMACH

| Period | *Number of Stomachs | Type of Food Organism: Pilchard | Herring | Smelt | Anchovy | Rockfish | Miscellaneous Fish | Unidentifiable Fish | Euphausid | Crab Larva | Miscellaneous Invertebrates |
|---|---|---|---|---|---|---|---|---|---|---|---|
| June 1–15 | 69 | ... | .3 | .1 | ... | ... | ... | ... | 21.2 | 13.4 | .1 |
| June 16–30 | 96 | ... | 1.2 | .2 | ... | .3 | ... | .4 | 17.0 | 4.2 | .7 |
| July 1–15 | 60 | ... | 3.0 | ... | ... | .1 | ... | 1.1 | 5.6 | .6 | .5 |
| July 16–31 | 28 | ... | 6.1 | ... | ... | .5 | .9 | 1.3 | 6.3 | .9 | ... |
| Aug. 1–15 | 56 | 6.0 | .9 | ... | .4 | 7.7 | ... | 7.4 | ... | ... | ... |
| Aug. 16–31 | 25 | 6.5 | 10.0 | ... | ... | ... | ... | 13.8 | ... | ... | ... |
| Sep. 1–15 | 67 | 2.0 | 1.1 | ... | ... | ... | ... | 1.2 | ... | ... | .8 |
| Sep. 16–30 | 59 | ... | 1.5 | ... | 1.0 | ... | 2.1 | .3 | ... | ... | .2 |
| Oct. 1–17 | 169 | .8 | .1 | ... | .1 | ... | 1.1 | .7 | ... | ... | .4 |
| Nov. 1–15 | 78 | ... | ... | .1 | ... | ... | ... | .3 | ... | ... | .1 |

* Includes empty stomachs.

TABLE 3
AVERAGE CONTENT OF CHINOOK SALMON STOMACHS FROM THE NEAH BAY AREA, 1938, GRAMS PER STOMACH

| Period | *Number Stomachs | Type of Food Organism: Pilchard | Herring | Smelt | Rockfish | Miscellaneous Fish | Unidentifiable Fish | Euphausid | Miscellaneous Invertebrates |
|---|---|---|---|---|---|---|---|---|---|
| Apr. 1–15 | 21 | ... | .9 | ... | ... | 1.6 | 4.0 | ... | ... |
| May 1–15 | 34 | ... | ... | ... | ... | ... | .4 | 6.0 | ... |
| July 16–31 | 36 | ... | ... | 4.1 | .8 | ... | 2.4 | 9.0 | ... |
| Aug. 1–15 | 21 | 2.3 | 28.0 | ... | 1.3 | ... | 8.3 | 2.8 | .5 |
| Aug. 16–31 | 47 | ... | 11.6 | 1.6 | .5 | 2.1 | 4.5 | .4 | .2 |

* Includes empty stomachs.

herring, anchovies, and rockfish. Small amounts of smelt and a few miscellaneous species were also present in some of the stomachs (Tables 1 to 4). A large part of the fish material could not be identified as to species because of its advanced state of digestion, although in a few instances badly digested material could be recognized by some skeletal characteristic, such as the striated operculum of the pilchard.

TABLE 4
AVERAGE CONTENT OF SILVER SALMON STOMACHS FROM THE NEAH BAY AREA, 1938, GRAMS PER STOMACH

| Period | *Number of Stomachs | Type of Food Organism | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Herring | Smelt | Rockfish | Miscellaneous Fish | Unidentifiable Fish | Euphausid | Crab Larva | Miscellaneous Invertebrates |
| July 16–31 | 38 | ... | ... | .1 | ... | .4 | 11.8 | .8 | ... |
| Aug. 1–15 | 53 | 7.5 | ... | .6 | ... | 4.6 | 1.5 | .1 | ... |
| Aug. 16–31 | 66 | 5.2 | .6 | .2 | .8 | 2.1 | .3 | ... | 1.2 |

* Includes empty stomachs.

The invertebrate material consisted almost entirely of crustacea, mostly euphausids for the chinook salmon (Tables 1 and 3), but including also a large proportion of crab larvae for the silver salmon (Tables 2 and 4). Small amounts of other invertebrates, such as squid, octopus, copepods, amphipods, etc., were present. Because the invertebrate material was largely crustacean, with hard, indigestible exoskeletons, none of it was unidentifiable. For the same reason, this material probably tended to accumulate in the stomachs more than the fish material. and thus be represented in greater than its true proportion to the latter.

## FLUCTUATIONS IN DIET, AND THEIR RELATIONSHIP TO CATCH

Inspection of the data on amounts of the various kinds of food organisms contained in stomachs indicated that there were two feeding phases for the species of salmon studied, a fish-eating phase and invertebrate-eating phase. Although the two overlap considerably, they are distinct enough to be recognized readily during the course of a season's sampling of stomach contents (fig. 2). The chinook salmon taken in the Westport area were in a fish-eating period when the 1938 fishing season began, in April. By the latter half of May they had shifted to a diet chiefly of crustacea, which continued to be their main item of food until the latter half of July. At this time the fish diet was resumed, and was continued until the end of the fishing season. Changes in the diet of the silver salmon were similar during the period when samples of that species were available (fig. 2).

The Neah Bay stomachs from chinook salmon taken in April and May, and from both chinook and silver salmon taken in June and July, indicated a diet similar to that at the Westport area (Tables 3 and 4). The amount of fish present in April and the amount of invertebrates in May were much smaller at Neah Bay than at Westport (6.5 grams per stomach as against 32.8, and 6.0 grams against 61.5). Because of the short part of the fishing season covered, and the discontinuity of the collections at Neah Bay, seasonal fluctuations in diet could not be accurately determined.

Consideration of the feeding habits of salmon and their relationship to the catch gives a clue as to the reason for the low fish content of stomachs during May and June. Persons who have made observations at sea report that during that period salmon feed on large swarms of crustacea present at the time, swimming with their mouths open so as to engulf their prey. When they

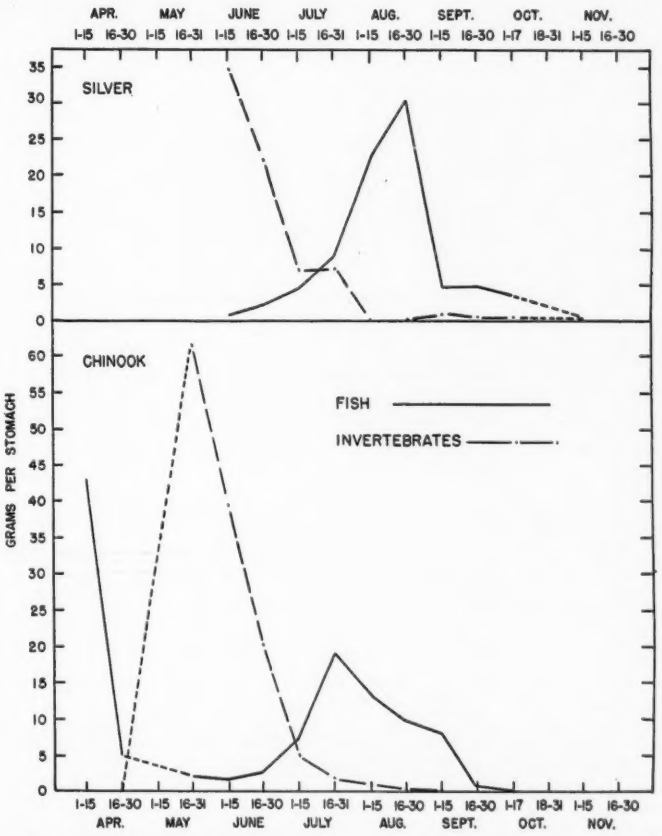


Fig. 2. Amount of invertebrate and of fish material contained in stomachs of salmon taken in the Westport area, 1938.

Short dash line indicates interpolation over periods when collections were lacking from series. Invertebrates were chiefly crustacea.

are feeding on fish, however, they behave in an entirely different manner, as any fisherman can testify. Then they strike at individual specimens, and with considerable force. Since the fishermen's lures are shiny pieces of metal bent in such a way that they resemble a wounded fish, the salmon naturally strike at them when feeding on fish. If, in May and June, the salmon change from a diet of fish to one of crustacea by choice rather than necessity, they would

probably not strike as readily as usual at fishermen's lures, and a low troll catch of salmon would result. This indicates the possibility of a correlation between the amount of fish eaten by salmon, and the troll catch.

An alternative explanation of the low fish content of stomachs in May and June would be that the fodder fish emigrate at that time from areas frequented by the fishermen. If they did so, the majority of the salmon might follow them, leaving only a relatively small number behind to be caught. These remaining salmon would be forced to eat the only food available to them—the crustacea.

Lack of precise knowledge as to the feeding habits of salmon on the one hand, and of migrations of fodder fish on the other, makes it impossible to verify either of the above hypotheses. However, in either case, one would expect to find a correlation between the amount of fish eaten by salmon, and the troll catch.

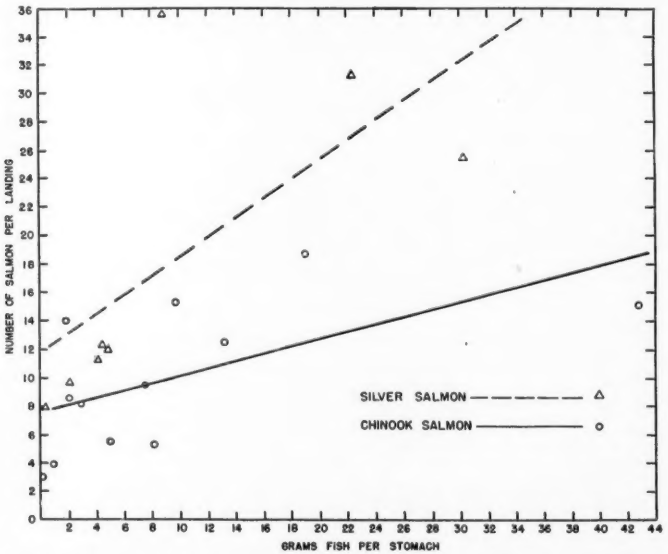


Fig. 3. Relationship between salmon catch and fish content of stomachs for the Westport area, 1938.
Each point represents a half-month's average. Regression lines are "least squares fits."

To determine whether or not such a correlation existed, the average weight of fish found in stomachs of salmon was compared with the average number of salmon per landing (a measure of catch per unit of effort). These two variables are plotted against each other in fig. 3. The coefficients of correlation are .5989 for the chinooks and .6807 for the silvers. According to Fisher's (1936) Table V A these values (with 10 and 6 degrees of freedom respectively) represent a fairly significant correlation (P=.04 and .07 respectively.)

In seeming contradiction to the correlation, a large catch of silver salmon

was taken in October and November, when the fish content of stomachs was small. This may have resulted from a condition not present during the other months of the study, namely, the sexual maturity of the silver salmon. The species is a "fall spawner" (Rounsefell and Kelez, 1935), and the fishing in October and November is largely upon schools starting their spawning migration to the streams and rivers. Since the silver salmon spawn closer to the mouths of the streams and rivers than the chinooks, the gonads of members of the former species preparing to make the upstream migration must be further developed than those of the latter.

Now it is known that the spawning fish do not feed normally after they have entered fresh water. That this influence extends also to fish nearing sexual maturity that are still in the sea, seems to be borne out by the extremely small amounts of food of any kind found in the stomachs of silver salmon collected in October and November (fig. 2). Nevertheless, the fish still strike at fishermen's lures, as evidenced by the large catch. There apparently persists in the ripe fish a reflex which causes them to strike at objects resembling fish, even though they do not swallow them. In view of this abnormal behavior, the months of October and November were omitted in correlating catch and amount of food in stomachs for silver salmon.

That the low catch of salmon in May, resulting from their eating crustacea rather than fish, is not a peculiarity of 1938, but may be an annual occurrence, is indicated by the fact that during the period April through October of 1935, 1936, and 1937 the catch of chinook salmon in the Westport area was lowest in May (Washington State Department of Fisheries, 1937: 22).

## Conclusion

A fair degree of positive correlation between the troll catch of salmon and quantity of fish in stomachs has been demonstrated for 1938, and some evidence has been presented indicating that this may hold true for other years. Thus it would seem that some part of the fluctuations in catch of salmon within seasons, and possibly also between seasons, may be caused by changes in the populations of fodder fish. The practical implication of this finding is that an apparent decrease in abundance of salmon, as indicated by the troll catch, may actually be due in part to lowered availability of some of the species of fish eaten by salmon.

## Literature Cited

Fisher, R. A.
1936 Statistical methods for research workers. London.

Rounsefell, G. A., and G. B. Kelez
1935 Abundance and seasonal occurrence of the salmon in Puget Sound and the development of the fishery. *U. S. Bureau Fish. Special Report*, 1934: 28 pp., 12 figs., 9 tables.

Schultz, L. P.
1936 Key to the fishes of Washington, Oregon, and closely adjoining regions. *Univ. of Wash. Publ. in Biol.*, 2 (4): 103–228, 50 figs.

Washington, State of, Department of Fisheries
1937 *Annual Bulletin* No. 37, 1937.

United States Fish and Wildlife Service, Jordan Hall, Stanford University, California.

# Notes on *Dendrobates auratus*

By Emmett Reid Dunn

THE following notes on *Dendrobates auratus* are partly from my own field experience and partly from a study of literature and of museum material. My field notes on the genus begin in 1920, and I seize the occasion to summarize our knowledge of "tadpole carrying" in the related genera *Phyllobates* and *Hyloxalus*.

The synonymy of *Dendrobates auratus* is as follows:

*Dendrobates auratus* (Girard)

*Phyllobates auratus* Girard, Proc. Acad. Nat. Sci. Phila. 7, 1855: 226. Collected on Taboga Island by Prof. Adams of Amherst. Type not certainly in existence but probably USNM 10307 which was collected by Adams.

*Hylaplesia tinctoria latimaculata* Günther, Cat. Batr. Sal. Brit. Mus., 1858: 125. Isthmus of Darien.

*Dendrobates trivittatus maculatus* Peters, Mon. Ber. Akad. Wiss. Berlin, 1873: 617. Chiriqui.

*Dendrobates amoenus* Werner, Verh. Zool.-Bot. Ges. Wien, 51, 1901: 627. Costa Rica. Type said to be in Königsberg; specimen labeled "type" examined in Vienna, No. 1904, 111, 95.

Range.—From Yavisa and Rio Esnape, Darien, to San Juan del Norte and San Miguelito, Nicaragua. Sea level on both coasts to 2000 feet at El Valle (Panamá). Taboga and Taboguilla Islands near Panamá City.

Geographical Variation. — Rio Esnape specimens have smaller and more numerous green spots. Elsewhere, especially in Costa Rica, the green areas increase in size and run together so that an effect of a green frog with black spots is produced. The species averages smallest on Taboga Island and largest in Costa Rica. Occasional individuals on Barro Colorado Island have a distinct reddish tinge to the black areas.

Material.—I have seen over 100 of these frogs on Taboga Island, and some 50 more at ten localities in Panamá and Costa Rica. Museum material examined amounts to 285 specimens, 185 of which came from Taboga and Taboguilla, on which islands it is extremely common. It is the only frog known from Taboguilla, but four other species occur on Taboga.

Relationships.—*D. auratus* is related to other *Dendrobates* with rounded light markings (*chocoensis*, etc.) which occur in the western part of Colombia, but in the Colombian forms the light color is red or yellow. From this same Colombian group may be derived two other gaudy Central American forms in which the red color persists, but in which the black background is reduced to scattered spots (*pumilio* = *"typographus" auct.*) or is entirely absent (*speciosus*). Typical *Dendrobates* (*tinctorius, trivittatus*, etc.) have dorso-lateral light lines like *Phyllobates*, and differ from *Phyllobates* chiefly in lacking maxillary teeth. To this typical group belong the Central American forms *lugubris, minutus*, and *shrevei*. The genus ranges from Brazil to Nicaragua and contains some eighteen species.

*Phyllobates* contains about twenty-three species ranging from Peru to Trinidad and Costa Rica. Six forms occur in North America. The type,

[1] Contributions from the Biology Department of Haverford College No. 51.

*bicolor,* was said to be Cuban, but has not been found anywhere recently, and is certainly not any of the known Central American forms. A third genus, *Hyloxalus,* differs from *Phyllobates* in having webbed toes. It ranges from Ecuador to Guiana and Panamá. There are eight species, two of them occurring in Panamá.

These three genera form a small group of diurnal frogs having firmisternal shoulder girdles and a pair of dermal scutes on the upper surface of the adhesive discs. Tadpole carrying has been observed for species of all three genera.

I am inclined to believe that *Sminthillus* of Cuba is an ally of *Phyllobates.* It looks like a *Phyllobates,* but lacks the dermal discs and has a somewhat different shoulder girdle. The frog is diurnal and the call is similar to that of *Phyllobates.* There is no tadpole stage, but the eggs are similar to those of *Dendrobates.*

Ecologically the five *Phyllobates* and two *Hyloxalus* species that I have seen in the field are normally associated with the banks of small streams, while the five *Dendrobates* and one *Sminthillus* species show no such association, but are more often found well away from water.

General Habits.—*D. auratus,* like all its allies that I have observed, seems wholly diurnal. The greatest activity is on mornings after rains. The only time I ever saw a *Dendrobates* at night was at La Castilla on April 27, 1936. It was on a leaf some 3 feet from the ground, and seemed to be asleep. They are not wholly terrestrial, and there is some correlation between their partly scansorial habits and their possession of adhesive discs.

The gaudy coloration is perhaps a warning. It is interesting to recall that *Dendrobates pumilio* was the first amphibian mentioned in connection with the theory of warning coloration (Belt, Naturalist in Nicaragua). Breder tells me that he was informed by Darien Indians that they used *D. auratus* as a source of arrow poison. I know that contact with them in a collecting bag is fatal to other frogs.

Liebesspiel.—We were on Taboga Island for three days in July, 1939. The weather was pretty dry, but there was a faint suspicion of rain in the air and a few drops fell during the night of the fourth. On the morning of the fifth there was great activity on the part of the *Dendrobates,* and we sat under the giant mango tree back of the hotel and watched them. The frogs were moving about all around us. The call was a low, soft, buzzing sound. The calling individuals appeared to us to be slightly smaller than those not calling, and to be marked with a brighter shade of green. The call was often given from a slight elevation, such as the highest point of a fallen mango leaf. There was no calling station: the males moved constantly, calling occasionally between hops. Some moved 30 to 40 feet while we watched them. A calling male was usually followed by several females, who sometimes actually jumped on him. The male seemed aware of his suite and if pursuit lagged would halt longer, become more vociferous, and finally disappear beneath the leaves, closely followed by one female, the others having paused by the wayside. In one such case after 30 minutes the female emerged and went off. The male came out a few minutes later, called once, and remained for awhile in the vicinity. We cleared around the areas of

three such disappearances and went back in the afternoon and examined all three places leaf by leaf, but found nothing. I do not know whether any actual mating took place.

Eggs.—We caught one "caller" and one "follower" and put them into a bag, which we kept damp. Next day we found two eggs together in the bag. The yolk mass was about 2 mm. in diameter and was surrounded by irregular, sticky, gelatinous material (no definite external film). In two other bags, which each contained some twenty *Dendrobates*, we found just such pairs of eggs. Dissection of a female showed six similar eggs. The eggs in the bags resembled no other frog eggs I have seen except those of *Sminthillus limbatus* of Cuba, which are laid singly on the ground and then abandoned.

Tadpole Carrying.—I had seen *D. auratus* and *D. pumilio, speciosus, minutus* and *shrevei* in the field, but never saw tadpole carrying in any *Dendrobates* until the season of 1940. This is in strong contrast to my experience with *Phyllobates*, in which I have observed the habit in all the forms I have seen (*beatriciae, talamancae, latinasus, flotator*, and *nubicola*). I might add that I have seen more individuals of *Dendrobates* than of *Phyllobates*.

Noble (1927: 104), under the name of *D. tinctorius*, mentions briefly that according to the field notes of C. M. Breder this species carries tadpoles. The reference is to *D. auratus*. The notes — dated April 23, 1924, on the Rio Sucubti, above Indian village — are as follows: "One *Dendrobates tinctorius* was carrying a single tadpole in the middle of its back. It was perfectly centered and headed forward. The hold was not relinquished for some time after preservation."

A paper by Eaton, published in this issue of Copeia, provides further information on this subject.

My 1940 notes are as follows. On the morning of September 4, on Taboga Island, several *D. auratus* (including three which each carried a single tadpole) were moving about on a large smooth-barked tree near the hotel. This tree had a number of small holes into which we could see. Higher holes that we could see probably contained water, and it is probable that there were others still higher. One of the tadpole-carrying frogs disappeared from sight about 40 feet up. All the frogs, in their peregrinations, investigated the water holes, and usually went in for a dip. The lower smaller holes contained no tadpoles, and none were left there by the frogs we watched although tadpole-carrying frogs entered water twice, one of them sitting with his head out for six minutes before he emerged still carrying his single tadpole.

Very little calling was heard, and no mating was going on. The call was timed and found to be of two seconds duration.

The frogs on the tree kept well out of the way of the larger ants, and one tadpole-carrying frog, in attempting to investigate a hole near the ground, was chased away by the small crab which inhabited it. The *Gonatodes* around the roots of the tree seemed indifferent to the *Dendrobates*, an indifference which was reciprocated.

Tadpoles.—I took six tadpoles (along with a single tadpole of *Phyllobates flotator*) in casual water in the hollow of a flattish stone (that looked

like an old metate) on Barro Colorado Island on November 22, 1928. The tadpoles were not carried through to transformation, but I took notes on their characters and have since checked the notes with tadpoles of *D. auratus*.

On April 30, 1936, at La Castilla, Costa Rica, a number of tadpoles of varying sizes were found in casual water in a rolled up palm frond on the ground. One of these, taken alive to San José, transformed into *D. auratus* on June 12 (a period of at least 42 days). Another, kept alive at La Castilla by my friend the late Ferdinand Nevermann, transformed there, and was killed by him on June 30 (a period of at least 60 days). Nevermann also sent me an *auratus* tadpole which he took on May 26, 1936, from "the sheath of a flower on the ground."

A Castilla tadpole shows the following characters: eyes farther apart than nostrils, nearer to snout than to spiracle; nostrils about halfway between eye and snout, farther than width of mouth; spiracle sinistral, slightly posterior to middle of body; anus median; no dorsal fin; labial border of papillae broadly interrupted dorsally; labial teeth 1, 1⅓, innermost upper series broken by a gap about equal to one of the bands of teeth, lower series decreasing in length ventrally; black above and below, caudal fin crests clear; length 40 mm., tail 25. These tadpoles differ from normal *Phyllobates* tadpoles only in greater size and heavier pigmentation.

Tadpole Carrying in other *Dendrobates*.—Tadpole carrying was first reported by Dr. Jeffries Wyman. His observations were made in May, 1857, in Dutch Guiana, briefly mentioned in November of that year (1857: 269), and more fully in 1859 (1859: 6, fig. 1). Specimens, both with tadpoles, are MCZ 10164 and 11030. These are *Dendrobates trivittatus*, not, as Wyman reported, *Hylodes lineatus*. Wyman erroneously thought that the female carried the larva, and that the entire development took place on the back of the parent, although he found the yolk nearly exhausted in those he examined. He states that the young, ten to fourteen in number, had their heads directed toward the middle of the parental back. He says they were three-quarters of an inch long, but Mr. Shreve informs me that "some . . . almost ⅝ inch . . . others . . . but slightly over ½ inch."

The next report, also from Dutch Guiana and also referring to *D. trivittatus*, appeared in 1885. August Kappler, who lived for 45 years in the colony, states (1885: 858): "In the rainy season the frogs spawn in little puddles, where the eggs are laid, and the young tadpoles are then taken up by the frog and taken to other puddles. For this purpose the frog, as I have many times seen myself, sits in the puddle, whereupon the tadpoles swim up to it and suck on to it so that it has a girdle of from 12 to 18 young 6–7 mm. long tadpoles on it, with which it then sets out on its trip to another puddle. I do not know whether it is the male or the female that arranges the transportation."

H. H. Smith (1887: 307–310) says that he heard about *Dendrobates* tadpole carrying at Santarem, Brazil, in 1875, and that he observed it himself "forty miles northeast of Cuyabá" in the Matto Grosso, in 1884. A year later a specimen with tadpoles was collected there by his assistant, W. C. Smith, and sent to Cope, who published a supplementary note identifying the species as *Dendrobates braccatus* (a close relative of *trivittatus*), and

giving a brief description of the tadpole (Cope, 1887: 310). The specimen is now ANS 13414. The tadpoles are no longer extant, but there were originally at least six. Smith thought the entire larval life was passed on the back, and Cope thought the carrier was the mother. No tadpole size is given.

Incidentally, Smith, in connection with this frog, makes the first suggestion that brilliant color, occasionally displayed, may serve to confuse and conceal ["flash coloration"].

Werner (1912: 326) alludes to a statement by C. B. Klunzinger that *D. trivittatus* "takes its larvae on its back when the ponds dry up and carries them from one body of water to another." I have been unable to find this reference.

I can find nothing in literature about growth or transformation in other species of *Dendrobates*. So far as our information goes, those found on the backs of parents were all small and young. The idea that older tadpoles are taken from one pond to another, or that the entire larval life is passed on the back of the parent seems to be inferential. Even Kappler's observations of the picking up of tadpoles may be questioned as being interrupted deposition of them. Kappler was not primarily a naturalist. His book "Surinam," published in 1887, contains one chapter on "Tierwelt"; the other chapters are concerned with natural resources, economics, possibilities of colonization from Germany, etc. The same paragraph on *D. trivittatus*, previously published separately in *Das Ausland*, occurs on page 138.

TADPOLE CARRYING IN *Phyllobates*.—The numerous accounts of *Phyllobates* may be summed up as follows: Males of *Phyllobates* have been taken carrying from 2 to 15 tadpoles. The tadpoles were always very small. Tadpoles of this size and larger, up to transforming tadpoles 32-36 mm. long, have been taken in pools at the edge of streams (occasionally in casual water). The inference is that only newly hatched tadpoles are carried. Whenever the sex of the carrier has been determined it was a male. Mated *Phyllobates* have been seen 8 feet up on the bank of a stream. A tadpole-carrying male has been seen a quarter of a mile from water.

TADPOLE CARRYING IN *Hyloxalus*.—I know of no previous report on the life history of *Hyloxalus*. Mr. George Lee has shown me a specimen of *H. fuliginosus* with 25 tadpoles that he took on Santa Rita Mountain, Feb. 21, 1936.

## LITERATURE CITED

COPE, E. D.
1887 [Note]: 310–311, 1 fig. in H. H. Smith: On oviposition and nursing in the batrachian genus *Dendrobates*. *Amer. Nat.*, 21: 307–311.

KAPPLER, AUGUST
1885 Die Tierwelt in holländischen Guiana. *Das Ausland*, 58: 857–859 [14th installment].
1887 Surinam, sein Land, seine Natur, Bevölkerung, etc. Stuttgart, J. G. Cotta: iii + 383, illus.

NOBLE, G. K.
1927 The value of life history data in the study of the evolution of the Amphibia. *Ann. N.Y. Acad. Sci.*, 30: 31–128, figs. 1–30, pl. 9.

SMITH, H. H.
1887 On oviposition and nursing in the batrachian genus *Dendrobates*. *Amer. Nat.*, 21: 307–311, 1 fig.

WERNER, FRANZ
1912 Die Lurchen und Kriechtiere. I. Brehm's Tierleben, 4: XVI + 572, 126 figs., 37 pls. Fourth edition, revised.
WYMAN, JEFFRIES
1857 [Exhibition of *Hylodes lineatus*]. *Proc. Boston Soc. Nat. Hist.*, 6: 268–269.
1859 On some unusual modes of gestation. *Amer. Jour. Sci.*, (2) 27: 5–13, figs. 1–5.

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# Notes on the Life History of *Dendrobates auratus*

By THEODORE H. EATON, JR.

THE observations reported here were made during the summer of 1939 at the Barro Colorado Island Biological Laboratory in Gatun Lake, Canal Zone, Panama. I am indebted for the facilities used to Mr. James Zetek, custodian of the laboratory.

Adults of *Dendrobates auratus* Girard were common in the forest, being seen equally often on the ground and climbing tree trunks. The black skin with glossy green spots makes them highly conspicuous, but their poisonous skin secretion apparently suffices for protection.

Although the summer was exceptionally dry, water stood in cavities in trees wherever these were exposed to rain, and usually one such hole would contain from one to ten or twelve tadpoles of *Dendrobates auratus*. The smallest amount of water in which any larvae were found was 13 cc., the largest about two gallons. A few insect larvae occurred in the water, together with many protozoans and rotifers, and some diatoms, but there was no growth of green vegetation. The intestines of the larvae examined contained minute fragments of wood, in which an occasional rotifer or protozoan was recognizable. I could not determine whether the wood supplied the actual nourishment for the larvae or not.

I made ten visits and collections of larvae at irregular intervals from July 9 to August 21, at a single tree hole on Slothia Island in Gatun Lake. This island is but a few yards offshore from Barro Colorado, and measures roughly 100 by 300 feet; there was only one tree hole in which water could stand, and at every visit this hole contained larvae which were removed at each visit. The hole was 4 feet up from the ground in the first crotch of a tree. It had approximately the shape and capacity of a quart beaker, and was not a decay hole. At the bottom lay about 2 inches of frass from dead leaves, in which the larvae sometimes hid. Frequently they swam slowly

in a vertical position, nibbling at the surface film, but most of the time they stayed quietly on the bottom or against the side walls. Even in the smallest ones the pigment was fully developed, except for slight paleness ventrally, and the dull black color made them quite inconspicuous unless a direct light was thrown on them.

I noticed that in the collections of larvae from a single tree hole the sizes and ages varied greatly; seldom were two just alike. On successive days the same hole would contain from one to three or four new larvae of small size, yet well past the hatching stage. On August 12 I observed a male depositing one larva in the water, and the next day another doing likewise. The details are as follows: at 3 P.M., August 12, a sunny, warm day, a male hopped to the base of the tree containing the hole and sat there for ten minutes in a small pool of water in a palm leaf. Then abruptly it climbed the tree to the rim of the hole, sat for a moment, caught a passing ant, then turned and backed cautiously down into the water. At this time I noticed that a small tadpole clung quietly to the lower part of the back. When the frog reached the water it floated vertically, its legs spread, while the tadpole wriggled free. In about ten seconds the latter was swimming by itself at the surface. The adult, some five seconds later, made a short jump and climbed out, stopping a few inches above the water. I took it for dissection and the larva for measurement. The adult, a male, had no modifications visible on its dorsal surface for attachment of the larva. Substantially the same events occurred at the same time of day on August 13, but this time I took the larva from the frog just before it reached the water. Measurements of both larvae are given in the accompanying table (measured August 12 and 13).

The data gathered in the table indicate the following facts: after larvae were removed from the tree-hole more were usually deposited within a day. Within three or four days several might be brought. When taken to the laboratory and kept in jars of approximately the same size as the tree-hole, with water and debris from the hole, the rates of development of different individuals differed greatly. A few did not grow during several weeks, while others increased rapidly. One taken on the main island transformed in a jar, developing the green spots at the time the tail was absorbed. It then spent part of the time in the water and part clinging to the side of the jar. The three larvae taken August 4 were kept 17 days before preserving and measuring, and they might have been deposited at any time after July 9, the date of the first collection, giving a possible total of 43 days of larval life. Two of these did not grow at all during their 17 days in the laboratory, but the third reached almost the maximum size for larvae of this species. The conditions may have differed enough from those of the tree-hole to be unfavorable for some individuals, but I am inclined to think that the different growth-rates prevail also under natural conditions.

Regarding adults on Slothia Island I have the following information: 1 taken Aug. 7, no evidence that it carried larvae; 1 taken Aug. 12 with tadpole at hole (male); 1 taken Aug. 13 in hole, presumably had just brought larva; 1 taken Aug. 13 at hole with larva (male); 1 taken Aug. 17, not at hole, female; 1 taken Aug. 21, not at hole, female; at least one more indi-

vidual must have used the hole later, as I saw four larvae there August 24.

Thus not less than three adult males, and probably five or six, came to the same hole to deposit larvae at different times during the period of observation. Careful searching did not reveal females accompanied by eggs, or a pair together, but the ovarian eggs in two dissected females were, as expected, few and in different stages of maturation. From one to four in each ovary measured between 2.2 mm. and 2.5 mm., the maximum diameter. Pigment was present over the upper three-quarters of these larger eggs, uniform black, fading to a mottled brown at the vegetal pole. In smaller eggs, from 1 to 2 mm. in diameter, the pigment covered an even larger area, indicating that pigment deposition is completed before the yolk is fully developed. Each of the larger eggs was accompanied by an artery going to that part of the ovarian membrane which surrounded it. The only difference noted externally between the male and female is the slightly fuller appearance of the latter, recognizable only by direct comparison. The distribution of spots on the skin is random in both, only one individual being noted in which all spots were placed symmetrically.

The measurements (in mm.), taken on August 21, of a subadult transformed August 14-16, from a tadpole collected August 4, are: body 14.8, fore leg 10.5, hind leg 20.5, body width 5.5; in an adult taken August 2, the same measurements are 27.5, 19.0, 36.0 and 9.0.

TABLE I

*Dendrobates auratus* TADPOLES TAKEN AT ONE TREE HOLE, SLOTHIA ISLAND, 1939

| Date taken | Days since previous catch | Date measured | Total length | Body length | Body width |
|---|---|---|---|---|---|
| July 9 | .. | Aug. 21 | 12.0 mm. | 5.5 mm. | 3.5 mm. |
| | | | 20.0 | 7.5 | 5.0 |
| | | | 30.5 | 12.0 | 9.8[1] |
| Aug. 4 | 26 | Aug. 21 | 14.5 | 6.0 | 3.8 |
| | | | 14.8 | 5.5 | 3.8 |
| | | | 29.0 | 11.5 | 8.5[2] |
| Aug. 7 | 3 | Aug. 21 | 14.0 | 5.5 | 3.5 |
| | | | 15.0 | 6.0 | 4.2 |
| | | | 16.0 | 6.2 | 4.3 |
| | | | 16.0 | 6.8 | 4.2 |
| | | | 20.0 | 8.5 | 6.5 |
| | | | 25.0 | 10.0 | 7.6 |
| Aug. 8 | 1 | Aug. 21 | 14.8 | 5.5 | 3.6 |
| | | | 14.8 | 5.6 | 3.8 |
| | | | 17.6 | 6.8 | 4.8 |
| Aug. 9 | 1 | Aug. 21 | 13.8 | 5.5 | 3.5 |
| | | | 15.5 | 6.0 | 4.2 |
| Aug. 12, A.M. | 3 | Aug. 21 | 17.5 | 6.8 | 4.5 |
| Aug. 12, P.M. | 0 | Aug. 12 | 15.0 | 5.0 | 2.5 |
| Aug. 13, P.M. | 1 | Aug. 21 | 17.0 | 6.8 | 4.8 |
| Aug. 13, P.M. | 0 | Aug. 13 | 14.5 | 5.0 | 3.0[3] |
| Aug. 17 | 4 | Aug. 21 | 16.5 | 6.5 | 4.5 |
| | | | 21.5 | 8.0 | 5.7 |
| Aug. 21 | 4 | Aug. 21 | 13.5 | 4.5 | 2.8 |
| | | | 14.5 | 5.0 | 3.5 |
| | | | 15.5 | 6.0 | 4.2 |
| | | | 16.5 | 6.0 | 4.4 |

[1] This larva had hind legs 17 mm., fore legs under skin.
[2] No legs yet visible.
[3] Taken from back of adult male.

ITHACA, NEW YORK.

# Notes on *Necturus maculosus* (Rafinesque), From Evans Lake, Michigan [1]

By Karl F. Lagler and Karl E. Goellner

ONE hundred and seven mudpuppies, *Necturus maculosus* (Rafinesque), were speared in Evans Lake, Lenawee County, between 9:00 P.M. and 1:00 A.M. on April 27–28, 1937, by a party engaged in the control of "noxious fish" under supervision of the Department of Conservation. The spearing was conducted from row boats in 2 to 6 feet of water, by means of ordinary fish spears with illumination from jack-lights. These specimens were studied with respect to food, sex ratio, size, and fecundity.

## Food

The stomachs of 105 of the 107 mudpuppies contained food for analysis, which indicates that the salamanders were foraging actively when taken. The results of our examination of this material may be tabulated as follows:

Food of *Necturus* in Evans Lake

Based on the Analysis of the Food (220.6 cc.) Contained in the Stomachs of 105 Individuals

| Food Item | Percentage Composition by Volume | Percentage Frequency of Occurrence |
|---|---|---|
| Fishes | 13.2 | 22.0 |
| Frog | trace | 1.0 |
| Turtles | 0.5 | 1.9 |
| Insects | 49.3 | 92.4 |
| Crustaceans | 13.9 | 30.5 |
| Earthworms | 20.0 | 34.3 |
| Snails | 3.3 | 22.0 |

## Annotated List of Food Items

Fishes.—*Lepomis macrochirus* (Rafinesque), the bluegill, was the sole game fish identified and was present in four stomachs. A pumpkinseed, *Lepomis gibbosus* (Linnaeus), was found in one individual. Remains of Centrarchidae undeterminable to genus or species occurred in eight salamanders. *Poecilichthys exilis* Girard, the Iowa darter, which is common in the lake, was found in only five stomachs. The specimen in one mudpuppy was a male in nuptial coloration, 1½ inches long. One other percid, estimated to have been 2 inches long, was present in another stomach. *Notropis heterodon* (Cope), the black-chinned shiner, was encountered five times; the individual in one stomach was 2 inches in length. Fish remains, unidentifiable even to family, were found in three stomachs.

Frog.—Bones of a small frog were found as a trace in one stomach.

Turtles.—*Sternotherus odoratus* (Latreille) was represented twice, once by a piece of skin, with the characteristic cornified area, from the hind leg of an adult male musk turtle, and once by a young individual 23 mm. in carapace length. This small turtle contained a minute quantity of filamentous algae.

[1] Based on research sponsored jointly by the American Wildlife Institute, the Institute for Fisheries Research of the Michigan Department of Conservation, and the Museum of Zoology and Department of Zoology of the University of Michigan.

INSECTS.—Aquatic insect nymphs and larvae constituted the most important groups of food items, at least as regards total volume and frequency of occurrence. The insect orders represented are considered in sequence of diminishing representation with the most common first:

(1) Mayfly nymphs were the dominant insects found; more than 200 individuals were present in each of several mudpuppies. The most commonly recurrent forms were: *Stenonema tripunctatum* (Banks), *Blasturus nebulosus* (Walker), *Ephemerella* sp. and *Ephemera* sp.

(2) Nymphs of Odonata, both dragonflies and damselflies, were found in 55 stomachs. Usually two or three individuals of this order, but never more than ten, were encountered in any one of these salamanders. Commonly recurrent genera of dragonfly nymphs were *Gomphus, Enallagma, Celithemis, Sympetrum,* and *Tetragoneuria.* The genera of damselfly nymphs that occurred most frequently were *Amphiagrion* and *Ischnura.*

(3) A group of miscellaneous insects composed a small percentage of the total volume of food. Larvae of Trichoptera (mostly Leptoceridae and Limnephilidae), and of Diptera (predominantly *Tipula, Stratiomyia,* and Chironominae) together exceeded in percentage frequency the total representation of the remaining orders in this group. Coleoptera were found as a few unidentified larvae, one adult dytiscid, and an adult of *Berosus* sp. Hymenoptera were represented by 16 individuals of *Apis mellifera* Linnaeus. Hemiptera in one stomach were adults of *Benacus* sp. and in another, *Pelocoris* sp. One lepidopterous larva was found in its case. Traces of unidentifiable insect fragments occurred twice.

CRUSTACEA.—*Cambarus propinquus* Girard was identified in 17 of the 24 mudpuppies in which crawfishes occurred. The amphipod, *Hyalella knickerbockeri* (Bate), and isopods of the family Porcellionidae together constituted only a very small percentage of the total food volume.

ANNELIDA.—Oligochaete earthworms were a food item of considerable importance. As many as 49 individuals, with a volume of 11.4 cc., occurred in one stomach. Hirudinea were identified in three instances.

GASTROPODA.—Snails of the following genera were frequently present but always in small numbers: *Lymnaea, Physa, Planorbula, Zonitoides, Gyraulus, Valvata,* and *Succinea.*

OTHER ITEMS.—The small amounts of plant detritus and sand, which many of the stomachs contained, were not considered as food.

## SEX RATIO AND SIZE

Males (61.7%) outnumbered females (38.3%) sixty-six to forty-one. Total length of each individual was measured from the tip of the snout to the end of the tail. The average total length of females was 271 mm. (232 to 318 mm.), whereas that of males was 263 mm. (194 to 313 mm.). Some loss of length due to the effects of preservation, as is known to occur for some fishes, may have occurred. The difference of average total lengths which we record for the two sexes confirms Bishop (1926), who states: "In any considerable series, the females average a little larger than the males."

## Fecundity

Little has been recorded as to the fecundity of the female *Necturus*. Eggs of two general stages of development were distinguishable in the ovaries of our specimens. Those of one stage averaged less than 0.5 mm. in diameter and were closely associated and tightly imbedded in the ovarian tissue. Those of the other stage averaged 4.5 mm. in diameter[2] and were characterized by an abundance of yolk and a distinct individuality in the distended ovarian membrane. Bishop (1926) gives 6 mm. as the approximate diameter of mature eggs. It therefore appears that the eggs of the larger size would soon have been deposited.

The average number of the larger eggs per individual, based on actual counts in the ovaries of 25 females, was 122 (75 to 193). That this figure may be taken as the average fecundity for the species is partly confirmed by the literature. Holbrook (1842) reported as many as 120 eggs in a female; Smith (1911) gives an average of 66 eggs per nest in 5 nests; and Bishop (1926) found an average of 107 eggs in 3 nests and reports counts of 90 to 180 eggs in several others. It is probable that counts of the large eggs within females just before spawning furnish a better index to fecundity than counts of eggs in nests, since guardian females are known to eat some of the eggs which they are attending and there is evidence that more than one female may spawn in the same nest.

## Parasites

Parasitization by the tapeworm, *Ophiotaenia lönnbergii* (Fuhrmann), was common.

## Acknowledgements

The authors acknowledge with sincere gratitude the helpful suggestions and criticisms given by Professors Carl L. Hubbs and S. C. Bishop and by Mrs. H. T. Gaige and Dr. A. S. Hazzard. Thanks are also extended to the following specialists for identifications of some of the organisms: Professor P. S. Welch, Oligochaeta; Dr. J. W. Leonard, aquatic insects; Dr. H. van der Schalie, Gastropoda; Mr. L. N. Allison, Cestoda.

## Literature Cited

Bishop, S. C.
1926 Notes on the habits and development of the mudpuppy, *Necturus maculosus* (Rafinesque). *New York State Mus. Bull.*, 268: 60 pp., 11 pls.

Holbrook, J. E.
1842 North American herpetology. J. Dobson, Philadelphia, 2nd Ed., 5: 116 pp., 38 pls.

Smith, B. G.
1911 The nests and larvae of *Necturus*. *Biol. Bull.*, 20: 191–200.

Department of Zoology, University of Michigan, Ann Arbor, Michigan.

[2] Average diameter of a random sample of 300 of these larger eggs from several females.

# A Review of the Lizards of the Genus *Uma*

By William Heifetz

THIS work was undertaken at the suggestion of Dr. Raymond B. Cowles, of the University of California at Los Angeles, who noted differences in the populations of *Uma* while he was engaged in studies concerned with desert reptiles. His report will cover the ecological problems within the genus; the present work is entirely taxonomic. The writer especially extends his thanks to Mr. C. M. Bogert for his constructive and valuable criticisms, his helpful supervision and encouragement, and also for notes on type specimens that the author could not examine.[1]

The lizards of the iguanid genus *Uma,* of the American southwest, are characterized by the presence of fringes of elongate spines on the sides of the digits and an ocellated dorsal pattern. The type species, *notata,* was inadequately described by Baird (1858: 253) from an immature specimen. Cope (1866: 310) supplemented this with a short note on an adult specimen, differentiating *Uma* from its relatives by the presence of the digital fringe. This second specimen later became the type of *Uma scoparia* (Cope, 1894: 435), distinguished from *notata* mainly by the larger number of femoral pores. In 1895 (p. 939), Cope named two additional species, *rufopunctata,* based on seven specimens from the "Yuma Desert, Arizona," and *inornata,* based on a single specimen from the "Colorado Desert, San Diego County, California." In 1896 (p. 1049), Cope synonymized *Uma* with *Callisaurus,* when he described *C. crinitus* and *C. rhodostictus* with digital fringes similar to those of *Uma,* but in 1898 (pp. 276–284), he revived *Uma* on the basis of other differences in scutellation and coloration. Camp (1916: 516), and later Van Denburgh (1922: 132), placed *inornata, scoparia,* and *rufopunctata* as synonyms of *notata,* apparently because Cope's diagnoses were only partly accurate. Since then there have been no important changes in the taxonomy of *Uma,* and no comprehensive study of the genus has been made.

Much of the confusion that has existed apparently has been caused by erroneous type localities. The type of *U. notata,* for example, reputedly from the "Mojave Desert," has no gular crescents, whereas all specimens from the Mojave Desert, as it is defined today, possess these characters. Gular crescents are found only in *scoparia,* the type of which allegedly came from "Fort Buchanan, Arizona." Neither type locality is correct, and the errors are doubtless to be attributed to the early practice of labelling specimens with the locality from which they were shipped.

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[1] Acknowledgements: The writer expresses his sincere thanks to the following institutions and individuals for their cooperation in lending material:
J. R. Slevin, California Academy of Sciences (CAS); L. M. Klauber, San Diego Society of Natural History (SDSNH), and also private collection (LMK); Dr. R. B. Cowles, University of California at Los Angeles (UCLA); K. P. Schmidt, Field Museum of Natural History (FMNH); Dr. E. Raymond Hall, Museum of Vertebrate Zoology, University of California (MVZ); Dr. Thomas Barbour and Arthur Loveridge, Museum of Comparative Zoology at Harvard College (MCZ); Dr. L. Stejneger and Dr. Doris M. Cochran, United States National Museum (USNM); Dr. G. K. Noble and C. M. Bogert, American Museum of Natural History (AMNH); Dr. Norman Hartweg, Museum of Zoology, University of Michigan (UMMZ); Dr. A. H. Wright and Harold Trapido, Cornell University Museum (CUM). Assistance in the preparation of this report was furnished by the personnel of Works Progress Administration Official Project No. 65–1–97–23 W. P. 10. The drawings of the head were made by Miss Leonore Boe.

Four forms are recognized in the present work: *Uma notata notata,* based on Cope's description of Baird's type [2] (1898: 277) and 229 specimens from the Colorado Desert; *U. notata cowlesi,* a new subspecies based on 13 specimens from the northwestern coast of Sonora; *U. inornata,* based on Cope's redescription of the type [3] (1898: 281) and 42 specimens from the restricted area of Coachella Valley, California; and *U. scoparia,* based on Cope's type and 153 specimens from the Mojave Desert.

The differences in pattern characters between the species are constant, and there is no intergradation, although there is a moderate overlap in the diagnostic scale characters. Three of the forms are considered to be full species on this basis, each population apparently being completely isolated from the others. The Mojave Desert population (*Uma scoparia*) is separated from the lowland Colorado Desert forms (*notata* and *inornata*) by the San Bernardino, Chuckwalla, and Chocolate Mountains, and the Coachella Valley population (*Uma inornata*) is isolated by mountains to the north, east, and west, and by the Salton Sea to the south. The habitat of *Uma* is restricted to areas of fine aeolian sand or to dunes (Camp, 1916: 516; Mosauer, 1935: 17, 19), so that migration from one population to another is limited at best, and possibly may not occur.

## *Uma* Baird

*Uma,* Baird, Proc. Acad. Nat. Sci. Phila., 10, 1858: 253; type *notata.* Cope, *Ibid.,* 18, 1866; 310. Cope, Amer. Nat., 28, 1894: 435, figs. 3, 4. Cope, *Ibid.,* 29, 1895: 939. Cope, Rep. U. S. Nat. Mus., 1898 (1900): 276–284, figs. 27, 28, 29. Van Denburgh, Occ. Pap. Calif. Acad. Sci., 10, 1922: 132. Schmidt, Bull. Amer. Mus. Nat. Hist., 46, 1922: 651, fig. 7, pl. 53. Mosauer, Ecology, 16, 1935: 7, 19, fig. 3. Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 4, 1939: 58.

*Callisaurus,* Cope, Amer. Nat., 30, 1896: 1049 (part). Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 1, 1917: 47 (part). Burt, Trans. Kans. Acad. Sci., 38, 1935: 272, fig. 22 (part).

DIAGNOSIS.—Most closely related to *Holbrookia* and *Callisaurus.* Separable from the former by the presence of an ear opening, and from the latter by the presence of long spines projecting over the ear opening, and of a digital fringe with small subdigital scales between the fringe and the lamellae, as noted by Schmidt (1922: 651).

Two complete rows of larger frontal plates between the supraocular regions, never a single row anteriorly. Cephalic plates small; largest scales in supraocular region rarely more than four times as large as the smallest. Femoral pores 18 to 47, usually more than 20. Digits and external margin of foot between fourth and fifth toes with fringes of narrow, elongate, projecting spines, largest on fourth toe and margin of foot, smaller on middle three digits, very small or lacking on first and fifth digits. In immature examples the fringe spines are proportionately shorter and broader at the bases. Males with two enlarged postanal scales.

Snout wedge-shaped in profile, with "countersunk" lower jaw. Form generally depressed, body rather flat, base of tail much depressed. Adpressed front limb not quite reaching base of femur; adpressed hind limb reaching

[2] The type of *notata* (USNM 4124) is completely dried and discolored to the point where no characters can be discerned.
[3] The type of *inornata* (USNM 16500) is lost.

beyond throat. Maximum total length 244 mm.; tail/total length ratio .49 to .64.

Dorsal ground color dirty white or gray, covered by a network of more or less regular black ocelli, with black or reddish-brown centers, the black broadly edged with reddish-brown. On the limbs the black is constricted into small round spots, while the ground color fuses with the reddish-brown to form a rather lighter reddish or pinkish ground. On head and tail the black network is indistinct and finer, with disintegrated ocelli, the ground color fusing as on limbs.

The shade and the presence of the reddish-brown bordering the ocelli seems to be determined largely by the color of the sand of the local habitat. In the desert west of Yuma, Arizona, and in Imperial County, California, where the sand is reddish, the brown of the lizard approaches a bright "Rufous" [4] color. In a lighter colored environment, such as Ford Dry Lake, to the north in Riverside County, the color is a more subdued "Ferruginous." About Palm Springs, where the sand is grayish, it is replaced by gray. Near Daggett the color bordering the black circlets is entirely absent, or sometimes replaced by a narrow edge of dark brown. The reddish-brown is visible in live or freshly preserved specimens only, fading to duller brown or gray in alcohol.

White below; some species with a large, black, elliptical or rectangular blotch on each lateral edge of the abdomen about midway between limbs. Occasionally a pair of small, black spots present in the preanal region (Meek, 1905: pl. 1). Three to ten black subcaudal cross-bars, which diminish in size to roundish blotches anteriorly; bars not present on regenerated tails. One or two black gular crescents present; in some species these are faint or completely obscure at the middle of the throat. A broad streak of red orange on each side of the abdomen sometimes present, but fading quickly in alcohol (postnuptial coloration?).

Juvenile examples greenish-gray, or light blue above, with the ocellations reduced to black and gray spots.

RANGE.—Confined to areas of fine, drifting sand in the Mojave and Colorado deserts in southern California, as far north as Kelso, San Bernardino County, west to northeastern Los Angeles County, California, east to Pembroke in Yuma County, Arizona, and south through northeastern Baja California, to Tepoca Bay, Sonora, Mexico.

REMARKS.—Of 422 specimens sexed, 193 were males and 225 females, giving a ratio of 1:1.17.

### *Uma notata notata* Baird

*Uma notata*, Baird, Proc. Acad. Nat. Sci. Phila., 10, 1858: 253; type locality, "Mojave Desert" (*in errore*, doubtless from the Colorado Desert, California); type USNM 4124. Cope, Amer. Nat., 28, 1894: 435. Cope, *Ibid.*, 29, 1895: 939. Cope, Rep. U. S. Nat. Mus., 1898 (1900): 277, fig. 27. Van Denburgh, Occ. Pap. Cal. Acad. Sci., 10, 1922: 132 (part). Schmidt, Bull. Amer. Mus. Nat. Hist., 46, 1922: 651, fig. 7, pl. 53 (part). Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 4, 1939: 58 (part).

*Callisaurus notatus*, Cope, Amer. Nat., 30, 1896: 1049. Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 1, 1917: 47 (part). Burt, Trans. Kans. Acad. Sci., 38, 1935: 272, fig. 22 (part).

[4] Quotation marks indicate Ridgway, 1912.

*Uma rufopunctata*, Cope, Amer. Nat., 29, 1895: 939; type locality, "Yuma Desert, Arizona;" cotypes USNM 21846–52. Cope, Rep. U. S. Nat. Mus., 1898 (1900): 279 fig. 28.

*Callisaurus rufopunctatus*, Cope, Amer. Nat., 30, 1896: 1049.

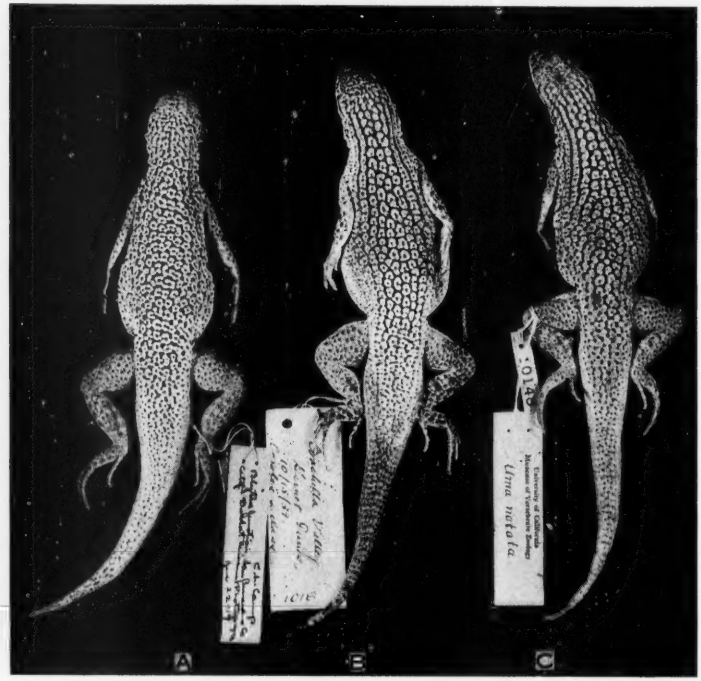


Figure 1. Dorsal View

A. *Uma scoparia* (MVZ 5456). From Blythe Junction, San Bernardino County, California. Showing scattered dorsal ocelli.

B. *Uma inornata* (UCLA 1018). From Garnet, Riverside County, California. Showing ocelli in semilineate pattern.

C. *Uma n. notata* (MVZ 10148). From Gray's Well, Imperial County, California. Showing ocelli in semilineate pattern.

TYPE.—The type, so inadequately described by Baird (1858: 253; USNM 4124), is an immature specimen now completely dried and discolored so that no characters can be discerned. From Cope's (1898: 277) description of the type and an examination of additional material, however, it is evident that the type is not from the "Mojave Desert" as stated in the original description. The gular crescents, so typical of the Mojave Desert population, are absent. The presence of only three internasals (Cope, 1898: fig. 27) and the low femoral pore count, both indicate that the type came from the Colorado Desert, as restricted today to include Imperial County, California; Yuma County, Arizona; and the immediately contiguous regions. The type locality accordingly should be restricted to the Colorado Desert,

and probably the type specimen came from the sand hills near Yuma, Arizona.

The cotypes of *U. rufopunctata* (USNM 21846–52), from the "Yuma Desert, Arizona" (part of the Colorado Desert as herein roughly defined), are referred to *U. n. notata*, since the true type locality of *notata* is certainly near that region, and if Cope's redescription of the type of *notata* is even moderately accurate, it agrees in diagnostic characters with *rufopunctata*.

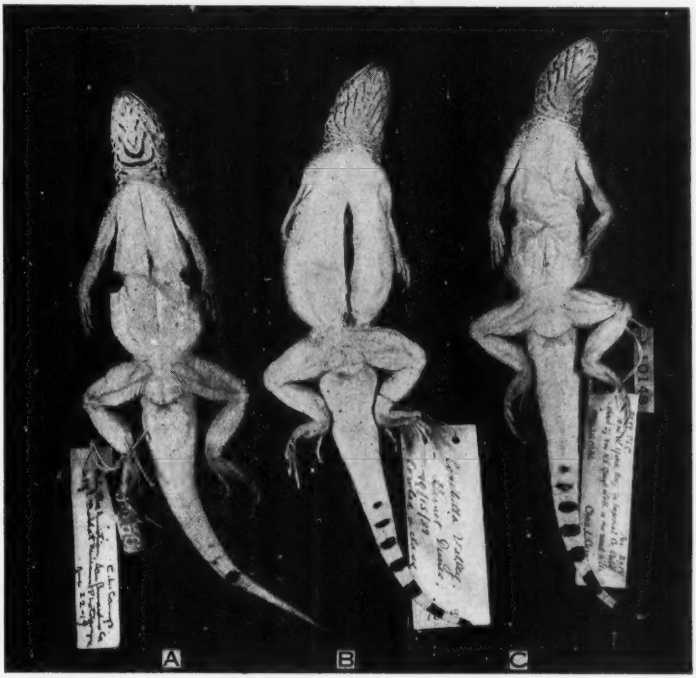


Figure 2. Ventral View

A. *Uma scoparia* (MVZ 5456). From Blythe Junction, San Bernardino County, California. Showing gular crescents and ventrolateral blotches.
B. *Uma inornata* (UCLA 1018). From Garnet, Riverside County, California. Showing immaculate venter.
C. *Uma n. notata* (MVZ 10148). From Gray's Well, Imperial County, California. Showing absence of gular crescents and presence of ventrolateral blotches.

DIAGNOSIS.—Ventrolateral blotch present. Pairs of thin lines on sides of throat and chin, slanting posterio-medially (see fig. 2, C), sometimes anterior pairs meeting as obscure lines in center to form irregular U's, dim and obscure at the middle of the throat. Usually three rows of internasal scales, counted between the posterior portions of the nostrils (see fig. 3). Femoral pores 20 to 31, rarely a secondary series below the first. Fringe spines on the external side of the fourth toe and along the sole from the fourth toe toward the base of the fifth, numbering 25 to 40. Dorsal ocelli arranged in

distinct, irregular, longitudinal rows, tending to fuse into lines on neck (see fig. 1, C). Rarely a pair of preanal spots; very rarely two enlarged prefemoral spots.

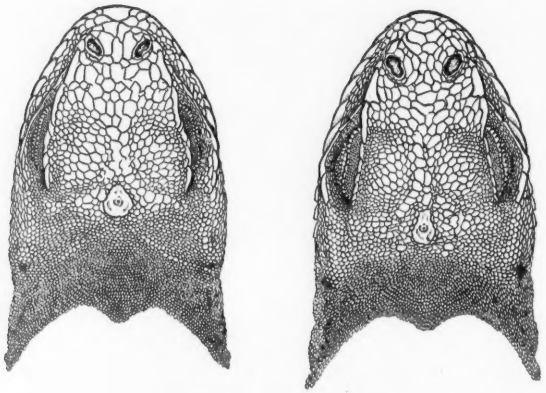

Fig. 3. *Uma n. notata* (FMNH 26182). From Winterhaven, Imperial County, California. Top of head, showing three internasal rows. ×2.

Fig. 4. *Uma scoparia* (FMNH 1203). From Daggett, San Bernardino County, California. Top of head, showing five internasal rows. ×2.

LOCALITIES.—From the following localities 229 specimens have been examined (see fig. 5):

CALIFORNIA: *Imperial County,* Winterhaven, Sand hills at numerous localities between 10 and 20 miles west of Yuma, Arizona, Gray's Well, Midway Well, Signal Mountain, Dixieland, Harper's Well, Tinhorn, Kane Springs, Sandy Beach, near Salton Sea, and New River, near Salton Sea. *San Diego County,* East base of Borego Mountain.

ARIZONA: *Yuma County,* Yuma, Wellton Mesa, and Pembroke.

MEXICO: *Baja California,* Mexicali, and Gardner's Laguna.

### *Uma notata* **cowlesi,** subsp. nov.

*Uma notata,* Van Denburgh, Occ. Pap. Cal. Acad. Sci., 10, 1922: 132 (part). Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 4, 1939: 58 (part).
*Callisaurus notatus,* Burt, Trans. Kans. Acad. Sci., 38, 1935: 272 (part).

DIAGNOSIS.—A subspecies of *Uma notata* differing from the typical form in having a comparatively smaller ventrolateral blotch, and a higher average femoral pore count.

TYPE.—CAS 53370, male, collected by Mr. Joseph R. Slevin, April 25, 1921, at Tepoca Bay, Sonora, Mexico.

DESCRIPTION OF TYPE.—Ratio of width of ventrolateral blotch to head and body length .027; width of ventrolateral blotch 2.4 mm.; snout to vent 88 mm.; tail 92 mm.; tail/total length ratio .51; gular crescents absent; femoral pores 28–28; fringe scales on fourth toe and margin of foot 34–34;

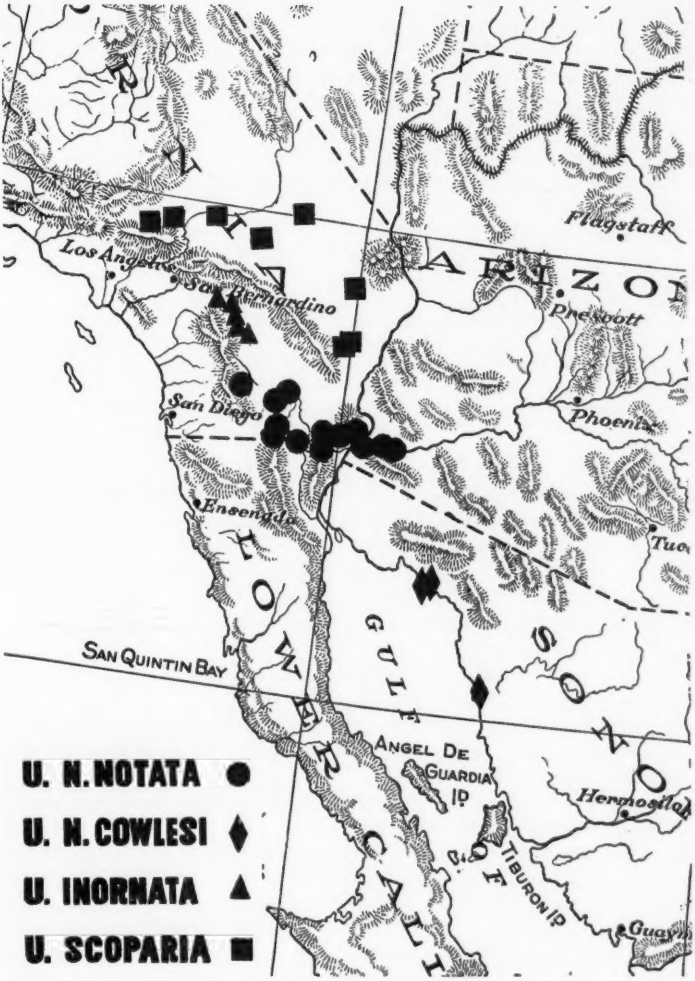


Fig. 5. Map showing distribution of lizards of the genus *Uma*.

three internasal scales posteriorly, five anteriorly; two rows of frontals; supralabials 7–7; infralabials 13–12; keeled suborbitals 5–4; superciliaries 5–5; five ear lappets; six subcaudal cross-bars.

PARATYPES.—The following specimens from Sonora, Mexico, have been examined: SDSNH 16460–64, Punta Peñasco; MVZ 26106, ½ mile northeast of Cerro Prieto; CAS 53368–69, 53371–74, Tepoca Bay. An exceptionally large ventrolateral blotch is present on MVZ 26106. The ratio of the width of the blotch to the head and body length is .068. Without this specimen, the maximum ratio for *U. n. cowlesi* is .040, only slightly overlapping the ratio of the typical form.

RANGE.—The northwestern coast of Sonora, Mexico, from Cerro Prieto to Tepoca Bay.

### *Uma inornata* Cope

*Uma inornata,* Cope, Amer. Nat., 29, 1895: 939; type locality, "Colorado Desert, San Diego County, California" (*in errore,* doubtless from Riverside County, California). Cope, Rep. U. S. Nat. Mus., 1898 (1900): 281.

*Callisaurus inornatus,* Cope, Amer. Nat., 30, 1896: 1049.

*Callisaurus notatus,* Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 1, 1917: 47 (part). Burt, Trans. Kans. Acad. Sci., 38, 1935: 272, fig. 22 (part).

*Uma notata,* Van Denburgh, Occ. Pap. Calif. Acad. Sci., 10, 1922: 132 (part). Schmidt, Bull. Amer. Mus. Nat. Hist., 46, 1922: 651, fig. 7, pl. 53 (part). Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 4, 1939: 58 (part).

TYPE.—The specimen described by Cope (1895: 939) is lost, but from his more detailed redescription (1898: 281), it is evident that the type belonged to the Coachella Valley population, which differs from all other species in not having a ventrolateral blotch. Despite the fact that the type locality has been given as San Diego County, it undoubtedly came from Riverside County. The collector, C. R. Orcutt, lived in San Diego and it may merely have been assumed that the specimen came from the county of the same name.

DIAGNOSIS.—Abdomen immaculate (see fig. 2, B). Similar to *U. n. notata* in all other characters. Gular markings like those of *U. n. notata;* usually three internasal rows; femoral pores 18 to 28; fringe scales on fourth toe 25 to 36; no reddish brown in dorsal pattern; dorsal ocelli arranged in semilineate pattern as in *U. n. notata* (see fig. 1, B).

REMARKS.—The close resemblance of *U. inornata* to *U. n. notata* might lead one to suspect that the former should be placed as a subspecies of the latter, since the only real distinction between them is the invariable and complete absence of the ventrolateral blotch in *inornata.* However, the absence of intergradation in the blotch character and the apparent isolation of the colony of *inornata* north of the Salton Sea, indicate specific separation.

LOCALITIES.—Forty-two specimens were examined from the following localities in Riverside County, California, (see fig. 5): Whitewater, Garnet, Palm Springs, Cathedral City, and Indian Wells.

### *Uma scoparia* Cope

*Uma notata,* Cope, Proc. Acad. Nat. Sci. Phila., 18, 1866: 310. Meek, Field Columbian Mus., Zool. Ser., 7, 1905: 4, pl. 1. Camp, Univ. Calif. Pub. Zool., 12, 1916: 516, figs. 6, 7, pl. 12. Van Denburgh, Occ. Pap. Calif. Acad. Sci., 10, 1922: 132 (part). Schmidt, Bull. Amer. Mus. Nat. Hist., 46, 1922: 651, fig. 7, pl. 53 (part). Stejneger

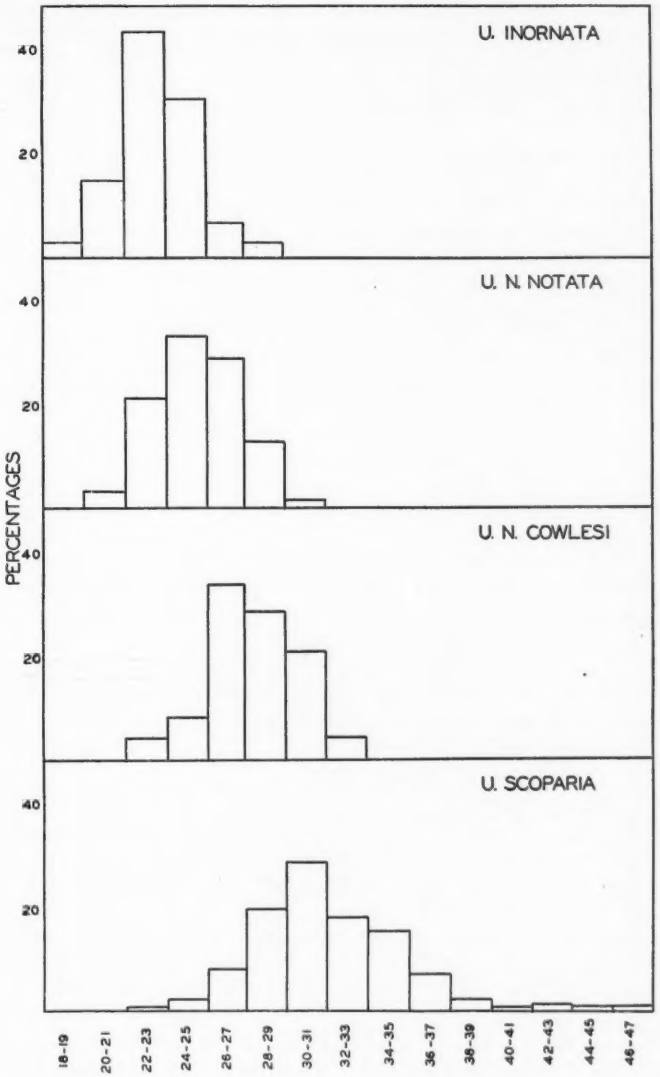


Fig. 6. Histogram showing the variation in the femoral pore counts for lizards of the genus *Uma*.

and Barbour, Check List N. Amer. Amph. and Rept., ed. 4, 1939: 58 (part).

*Callisaurus notatus*, Burt, Trans. Kans. Acad. Sci., 38, 1935: 272, fig. 22 (part).

*Uma scoparia*, Cope, Amer. Nat., 28, 1894: 435, figs. 3, 4; type locality, "Fort Buchanan, Arizona" (*in errore*, probably from San Bernardino County, California); type USNM 6063. Cope, *Ibid.*, 29, 1895: 939. Cope, Rep. U. S. Nat. Mus., 1898 (1900): 282, fig. 29.

*Callisaurus scoparius*, Cope, Amer. Nat., 30, 1896: 1049. Stejneger and Barbour, Check List N. Amer. Amph. and Rept., ed. 1, 1917: 48.

TYPE.—An examination of recently collected material indicates that the alleged type locality of *U. scoparia* is geographically beyond the known or probable range of lizards in the genus. The most easterly locality that can be authenticated is Pembroke, Arizona, for specimens belonging to the Colorado Desert species, *Uma n. notata*. The type of *scoparia*, USNM 6063, agrees in all respects with the Mojave Desert population.

DIAGNOSIS.—Ventrolateral blotch present. Two, or occasionally one, black gular crescents present, widest at the middle of the throat (see fig. 2, A); anterior to these one or two V-shaped markings are usually present. The crescents occasionally reduced to short black bars with indistinct ends curving anteriorly. Five rows of internasal scales normally present (see fig. 4). Femoral pores 22 to 47, averaging considerably higher than in *U. n. notata*. Fringe spines on fourth toe 28 to 40, also averaging higher than in *U. n. notata*. Dorsal ocelli scattered, and never forming a semilineate pattern (see fig. 1, A). Black never fusing into lines on neck. Preanal spots often present, especially in Daggett specimens. Two enlarged black spots usually present on the sides anterior to the insertion of the femur; these are especially distinct in Blythe Junction and Ford Dry Lake specimens.

LOCALITIES.—One hundred fifty-four specimens were examined from the following localities in southern California:

*Riverside County*: Hopkin's Well and Ford Dry Lake.

*San Bernardino County*: Rice (Blythe Junction), Ludlow, Kelso, Daggett, and El Mirage.

*Los Angeles County*: Wilsona P. O.

## DIFFERENCES BETWEEN SPECIES

Cope (1898: 276-284) gave lengthy diagnoses of his species, but since they were based largely on single specimens the differences he pointed out were mostly individual. In the present work, with the larger amount of material available, the diagnostic characters were subjected to statistical analysis to ascertain whether they were significant.

Besides the important pattern differences which are fully discussed above, and which do not lend themselves readily to statistical analysis, there are the following variable characters that have proved significant:

INTERNASALS.—In the Colorado Desert form there are normally three rows of internasal scales; in the Mojave Desert form there are usually five. Despite an overlap, this character is highly significant (see figs. 3 and 4).

| | Specimens Examined | (Percentage in Each Class) 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| *U. n. notata* | 221 | 2.3 | 92.8 | 6.3 | 0 | 0 |
| *U. n. cowlesi* | 12 | 0 | 66.7 | 25.0 | 8.3 | 0 |
| *U. inornata* | 40 | 2.5 | 90.0 | 7.5 | 0 | 0 |
| *U. scoparia* | 146 | 0 | 2.7 | 19.2 | 77.4 | .7 |

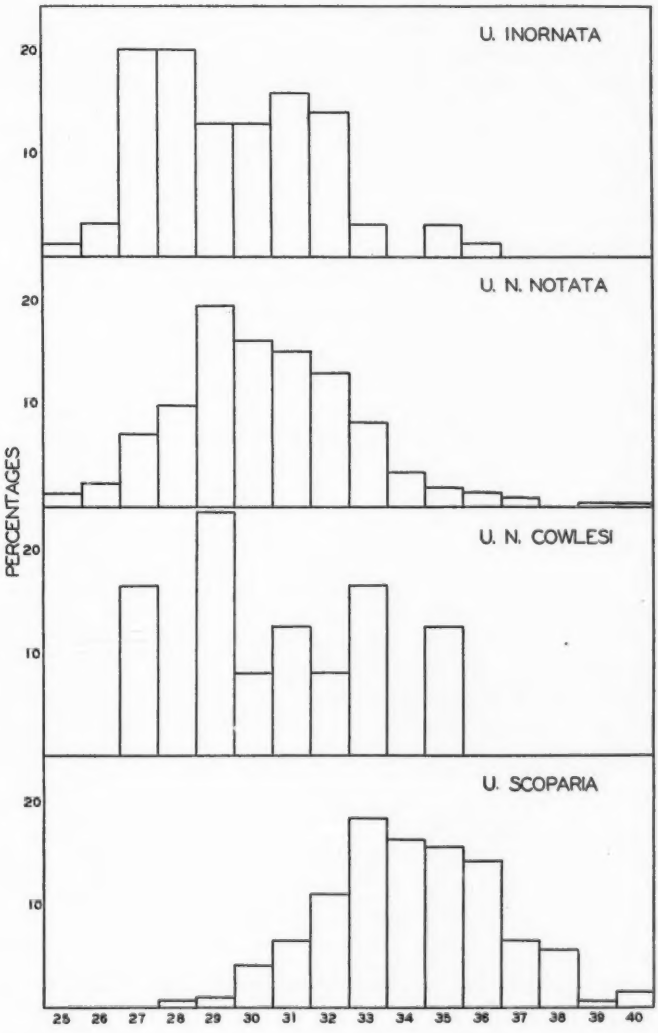


Fig. 7. Histogram showing the variation in the fourth toe fringe scale counts for the lizards of the genus *Uma*.

FEMORAL PORES.—*U. scoparia* has a much higher average count than *U. n. notata*. In the former the femoral pore scales are smaller, closer together, and often with a smaller secondary series below the first one. The average count for *U. n. cowlesi* is likewise significantly higher than for *U. n. notata*, the difference between the means being 6.1 times greater than the standard error of the difference. Each specimen is considered as having two separate counts, one on each femur (see fig. 6).

| | EXTREMES | MEAN | |
|---|---|---|---|
| *U. n. notata* | 20 — 31 | 25.127 | ±.1020* |
| *U. n. cowlesi* | 23 — 32 | 27.875 | ±.4796 |
| *U. inornata* | 18 — 28 | 23.105 | ±.2240 |
| *U. scoparia* | 22 — 47 | 31.408 | ±.2135 |

* Standard error of the mean.

FRINGE SPINES.—The fringe spines are counted on the external side of the fourth hind toe, from the claw toward the base of the fifth toe as far as the spines are distinct and the scales enlarged. There is considerable variation in this character. However, the difference between the means of *U. n. notata* and *U. scoparia* is 22.4 times as large as the standard error of the difference, showing that, despite great overlap, the average difference is still significant. As above, each individual is considered as having two separate counts (see fig. 7).

| | EXTREMES | MEAN | |
|---|---|---|---|
| *U. n. notata* | 25 — 40 | 30.323 | ±.1160 |
| *U. n. cowlesi* | 27 — 35 | 30.667 | ±.5205 |
| *U. inornata* | 25 — 36 | 29.300 | ±.2691 |
| *U. scoparia* | 28 — 40 | 34.158 | ±.1355 |

VENTROLATERAL BLOTCH.—The ratio of the width of the ventrolateral blotch to the head and body length is significantly smaller for *U. n. cowlesi* than for *U. n. notata*. The difference between the means is 5.09 times greater than the standard error of the difference.

| | EXTREMES | MEAN | |
|---|---|---|---|
| *U. n. notata* | .038 — .084 | .056 | ±.0028 |
| *U. n. cowlesi* | .019 — .068 | .034 | ±.0033 |

## KEY TO THE LIZARDS OF THE GENUS *Uma*

I. Ventrolateral blotches present

A. Gular crescents present, broadest at the middle of throat; internasals usually five; femoral pores usually more than 29; dorsal ocelli scattered ..... *Uma scoparia* Cope

(The Mojave Desert of California, from eastern Riverside County, north to Kelso in San Bernardino County, and west to northeastern Los Angeles County.)

B. Gular crescents absent or obscure at the middle of the throat; internasals usually three; femoral pores usually fewer than 29; dorsal ocelli in lineate pattern

1. Ratio of width of ventrolateral blotch to head and body length usually over .04; femoral pores usually fewer than 26..... ..... *Uma notata notata* Baird

(California, Arizona and Baja California from extreme eastern San Diego County through sandy portions of Imperial County, California, east to southwestern Yuma County, Arizona and northeastern Baja California.)

2. Ratio of width of ventrolateral blotch to head and body length usually less than .04; femoral pores usually more than 26..... .....*Uma notata cowlesi*, subsp. nov. (Northwestern coast of Sonora, Mexico, from Cerro Prieto to Tepoca Bay.)

II. Ventrolateral blotches absent

A. Gular crescents absent; internasals usually three; femoral pores usually fewer than 29; dorsal ocelli in lineate pattern ..... .....*Uma inornata* Cope (Restricted to Coachella Valley, in central Riverside County, California, from Whitewater to Indian Wells.)

## Literature Cited[6]


Baird, S. F.

1858 Description of new genera and species of North American lizards in the Museum of the Smithsonian Institution. *Proc. Acad. Nat. Sci. Phila.*, 1858: 253–256.

Burt, C. E.

1935 A key to the lizards of the United States and Canada. *Trans. Kans. Acad. Sci.*, 38: 255–305, 71 figs.

Camp, C. L.

1916 Notes on the local distribution and habits of the amphibians and reptiles of southeastern California in the vicinity of the Turtle Mountains. *Univ. Calif. Pub. Zool.*, 12: 503–544, 7 figs. pls. 19–22.

Cope, E. D.

1866 On Reptilia and Batrachia of the Sonoran Province of the Nearctic Region. *Proc. Acad. Nat. Sci. Phila.*, 18: 300–314.

1894 On the iguanian genus *Uma* Baird. *Amer. Nat.*, 28: 434–435, 4 figs.

1895 On the species of *Uma* and *Xantusia*. *Ibid.*, 29: 938–939.

1896 On the genus *Callisaurus*. *Ibid.*, 30: 1049–1050.

1900 The crocodilians, lizards, and snakes of North America. *Ann. Rep. U. S. Nat. Mus.* 1898: 155–1294, 347 figs, 36 pls.

Meek, S. E.

1905 An annotated list of a collection of reptiles from southern California and northern Lower California. *Field Columbian Mus., Zool. Ser.*, 7: 1–19, 3 pls.

Mosauer, Walter

1935 The reptiles of a sand dune area and its surroundings in the Colorado Desert, California: a study in habit preference. *Ecology*, 16: 13–27, 9 figs.

Ridgway, Robert

1912 Color standards and color nomenclature. Published by the author; Washington, D. C.; i–iii, 1–43, 53 pls.

Schmidt, K. P.

1922 The amphibians and reptiles of Lower California and the neighboring islands. *Bull. Amer. Mus. Nat. Hist.*, 46: 607–707, 13 figs., pls. 47–57.

Stejneger, Leonhard and Thomas Barbour

1917 A check list of North American amphibians and reptiles. Harvard University Press, Cambridge, ed. 1: i–iv, 1–135.

1939 *Ibid.*, ed. 4: i–xvi, 1–207.

Van Denburgh, John

1922 The reptiles of western North America: Vol. I, Lizards. *Occ. Pap. Calif. Acad. Sci.*, 10: 1–611, 57 pls.


American Museum of Natural History, New York City.

[6] The bibliography and the various synonymies have been curtailed to include only the more important works.

# Herpetological Notes

NOTES ON A TADPOLE OF *DENDROBATES AURATUS*.—The following notes were wrtten in 1938 at the Laboratory of the Institute for Research in Tropical America at Barro Colorado Island in the Canal Zone. *Dendrobates auratus* seems to have been fairly common, but its small size and secretive habits make it rather hard to find.

July 19. Collected a black tadpole with hind legs from a pool in a root in the trail near Van Tyne big tree. The pool may have contained a pint of water.

July 30. Tadpole is metamorphosing and has thrust its left arm out of the spiracle. No webs show on toes or fingers, but there are small finger disks. Length 31 mm. Tail rather narrow with rounded end. A little barring appears on the feet.

Aug. 2. Tadpole metamorphosing rapidly. All its legs are out and the tail is shorter than the body. A pair of conspicuous light spots shows behind the eyes and the canthus rostralis is light, as are the lateral folds.

Aug. 5. Metamorphosis complete except for tail stub. Length snout to vent, 14 mm. Green markings conspicuous.

Aug. 8. Tail stub gone. Preserved in alcohol.—PHILIP H. POPE, *Whitman College, Walla Walla, Washington.*

*LAMPROPELTIS ALTERNA* FROM MEXICO.—A specimen of *Lampropeltis alterna* (H.M.S. Field No. 11505) was found in a crack in a large boulder on the northern side of a barren hill (the old Cruz Verde Mountain) just west of Saltillo, Coahuila, on October 15, 1939. This is the first specimen known from Mexico and the third specimen known of the species. Preoculars 1–1; postoculars 3–3; temporals 2 +3, 3 + 4; scale rows 25–23–19; ventrals 220; subcaudals 64; one or two scale pits, apparently more scales with one than with two. Maxillary teeth 13, two posterior slightly enlarged. Hemipenis (dissected) bilobed, tips with calyces; sulcus single; spines small, numerous, extending half way to base of organ; two or three basal ridges, branching distally and forming seven or eight ridges which disappear at the edge of the area of spines. Black annuli indistinct anteriorly and posteriorly, most distinct near middle of body; 33 red annuli on body; 10 annuli on tail, the last 3 with no red. Total length 810 mm., tail 128 mm.—HOBART M. SMITH, *U. S. National Museum, Washington, D. C.*

SYNONYMY OF *TANTILLA NIGRICEPS FUMICEPS* COPE.—*Scolecophis fumiceps* Cope (Proc. Acad. Nat. Sci. Phila., 1860: 371), described without definite locality data (erroneously stated "Probably Cuba"), seems to be the same as *Tantilla kirnia* Blanchard (Zool. Ser. Field Mus. Nat. Hist., 20, 1938: 373–4), which it long antedates. The type of *fumiceps* is in the U. S. National Museum, not in the Museum of Comparative Zoology as stated by Cope. In the original description the ventrals and caudals are given as 132 and 42 respectively; I count 135 and 42 (male). The measurements were stated "Total length 5 inches; tail 1 in. 10 lin." The total length actually is 9 inches, while the tail measures slightly more than 1 inch, 9 lines (44.5 mm.). The total length measurement given by Cope is evidently a misprint.

Since the chief difference between typical *nigriceps* and *kirnia* lies in ventral counts (146 to 159 in males of the former, 130 to 138 in the latter, *fide* Blanchard), the conspecificity of *fumiceps* and *kirnia* seems rather certain. The subspecies accordingly retains its identity as *Tantilla nigriceps fumiceps* (Cope).

It is of interest that, so far as data now show, *Homalocranion praeoculum* Bocourt (Miss. Sci. Mex., Rept., 1883: 582, pl. 36, fig. 8) is also a synonym of *fumiceps*. The type, described from "Colorado," was considered distinct from *planiceps* largely because of the possession of two preoculars, an anomaly. The type is said to have 130 ventrals and about 50 caudals. These counts, together with the head markings depicted in the illustration, are possible only in *fumiceps*.—HOBART M. SMITH, *U. S. National Museum, Washington, D. C.*

NOTES ON *PLETHODON CINEREUS* AND *HEMIDACTYLIUM SCUTATUM* ON CAPE COD.—While collecting eggs of *Plethodon cinereus* for a study of some of the details of development of this salamander, certain incidental observations were made which were not especially pertinent to the problems under investigation.

It has long been known that the salamanders of the genus *Plethodon* possess no aquatic larval stage but lay large-yolked terrestrial eggs from which the young emerge with the definitive body form. The eggs of *Plethodon cinereus* were first described by Putnam (1865, Proc. Boston Soc. Nat. Hist., 9: 173) and isolated records have been published by a number of authors since that time. It appears however, that only two workers, Piersol (1910, Trans. Canadian Inst., 10: 121–126) and Cochran (1911, Biol. Bull., 20: 332–349), have had more than one or two clutches of eggs for study. Their papers therefore constitute the main sources of information concerning the breeding habits and developmental history of this species.

The eggs are usually deposited within cavities in fallen logs. Pine logs, lying in damp humus and in advanced stages of decay, seem to be most favored. Possibly this is only because such logs exhibit more extensive systems of cracks and crevices than do decaying logs of deciduous trees, but it may also be related to the fact that molds do not seem to be as abundant in the former as in the latter. The eggs, as Piersol noted, are very susceptible to fungus infections. Each clutch of eggs is suspended like a bunch of grapes from the cavity in which it is laid, and the mother remains coiled about the eggs until they have hatched.

Previous records as to the number of eggs in a clutch are in fair agreement. Piersol gives the number as 3 to 12; Cochran found clutches of 5 to 9, and Mohr (1935, Nat. Hist., 36: 115–173) states that the number is 3 to 13. Blanchard (1928, Am. Nat., 62: 156–164), on the basis of dissections of 91 adult females, records a variation of 5 to 13 in total egg complements. During the past summer 23 clutches of eggs were collected by the present authors in the region of Woods Hole, Mass. The largest clutch contained 14 eggs while the smallest contained only one. It is possible that the latter may have included other eggs which had previously hatched, for the clutch was found late in the season. However, no young salamanders were found nearby and Piersol has noted that newly hatched broods usually remain near the parent for some time. Despite the great range in number of eggs in a clutch only a few cases lie at the extremes of the range and nearly half the clutches contained just 7 eggs. This is shown in the accompanying table.

| No. of eggs | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of clutches | 1 | 0 | 1 | 1 | 0 | 2 | 10 | 2 | 0 | 0 | 4 | 1 | 0 | 1 |

The time of deposition of the eggs extends over a considerable period. Blanchard states that, in Michigan, egg-laying probably occurs during early or middle June; Cochran records egg-laying in Worcester County, Massachusetts, in July and early August, and Piersol says that, in Ontario, eggs in early cleavage stages were taken between June 16 and July 3. Mohr maintains that egg-laying may continue from mid-June into September. Wooded areas near Woods Hole, Massachusetts, were searched frequently during the last half of June and during July and August, 1940. Eggs were first found on June 23. One of these eggs was undergoing gastrulation and the others exhibited well-defined blastopores on the following day. This indicates that the eggs were laid a few days before they were discovered, probably about June 18. No eggs were found which gave evidence of having been laid previous to this date. On July 11 a female which had been collected on the preceding day laid 3 eggs. Ten more clutches were found after July 11 but none of these were in such a state of development as would indicate that they were laid after July 20.

No accurate information concerning the exact period of development within the eggs is to be found. Cochran collected eggs containing advanced larvae during the latter part of August, and Piersol observed hatching during the first week in September. We collected some 35 eggs around August 1, and some of these were kept on damp filter paper inside sterile Petri dishes until they hatched. Hatching occurred during the last week of August. The indication is that the development in the egg requires well over a month. It should be mentioned that Sherwood (1895, Proc. Linn. Soc. New York, 7: 21–37) has recorded finding eggs of *Plethodon* on October 25. This late date is not

in accord with any other published record and, as Piersol has pointed out. since it is not accompanied by any description of the eggs it must be regarded with some doubt.

Some 20 or 30 females of *Plethodon cinereus,* through the skin of which masses of eggs could be seen, were maintained throughout most of the summer in terraria. Only two of these animals laid their eggs, both depositing the eggs within 24 hours after they were captured. Probably the fact that most of the females failed to lay is ascribable to unfavorable nutritive conditions. It appears that only animals which were just on the point of laying when collected did so. All others retained their eggs and there is good evidence that gradual resorption then occurred.

An interesting feature of *Plethodon cinereus* is the relative abundance of the so-called "red-backed" and "gray-backed" varieties. Blanchard found that, in Michigan, the two colors occurred in about equal numbers. We have found, in a series of 166 specimens collected near Baltimore, Maryland, a predominance (71%) of the gray form. At Woods Hole, on the other hand, the gray form is very seldom found. Among a series of 84 animals collected at random in this region, only 12 (14%) were of this type. Further analysis of the ratios of these two types in other localities should be of interest.

During the course of the collecting at Woods Hole two adult specimens of *Hemidactylium scutatum* were found in rotted logs, habitats identical with those occupied by *Plethodon.* Dunn's records for *Hemidactylium* (1926, Salamanders of the Family Plethodontidae: 203) reveal that this salamander has previously been found in Massachusetts only in the region of Springfield and Northampton and in the vicinity of Boston. Its presence on Cape Cod therefore seems worthy of note.—W. GARDNER LYNN and JAMES N. DENT, *The Johns Hopkins University, Baltimore, Maryland* and *The Marine Biological Laboratory, Woods Hole, Massachusetts.*

BIRTH OF HORNED TOADS.—A specimen of Hernandez's horned toad (*Phrynosoma douglassii hernandesi*) was received by the Biological Survey, in Washington, D.C., from Cochise County, Arizona, early in July, 1937. This specimen gave birth to 15 young during the morning of July 5. A summary of detailed notes made on the spot by Leon H. Kelso and the writer follows.

Ten of the young were born prior to 9:30 A.M., when the event was first called to the writer's attention. The remaining 5 arrived at 9:31, 9:42, 9:55, 10:30, 10:45, respectively. Three of the first ten were born between 9:00 and 9:30, but the exact time was not recorded.

The mother assumed a position with body raised, not touching the ground, dropped the young, and moved off a few inches. She showed absolutely no interest in subsequent events. Birth was accompanied by the discharge of one or two drops of watery fluid.

Each of the young was surrounded by a watery fluid that was enclosed in a thin. fragile, transparent membrane. In some cases the posterior end of the fetus emerged first, while in others, the opposite end emerged first, but the fetus was always dorsal side uppermost. The fetus was not curled within the membrane except that the tail was pressed tightly against the right side of the body.

After birth, the fetus remained motionless for a period of time varying in these specimens from five to fifty-five minutes. The first motion was a wriggling one, and was continued, in some cases intermittently, until the egg membrane was broken. Then the lizard gasped for breath, swallowed a few times, and crawled off several steps to dry. After the young are dry their actions are similar to those of adults. There was a definite umbilicus, a trace of which remained visible for several days. Usually the membrane broke near the anterior end of the fetus, where motion was most violent. After emergence the membrane was left to desiccate. Occasionally it broke elsewhere allowing the fluid to drain and the membrane to envelop the fetus. Upon drying this formed a glovelike covering which prevented the young from breathing. This may cause an occasional fatality. One young lizard was exhausted by its struggles when the writer interposed and removed it from the membrane, thus allowing it to breathe.—CLARENCE F. SMITH, *Fish and Wildlife Service, Mt. Shasta, California.*

A PRACTICAL LIZARD TRAP.—In the course of studies of the behavior and ecology of *Tropidurus peruvianus*, a practical and simple trap, that may be of interest to herpetologists, has been developed. It consists of a wooden platform, 1 m. square and 5 cm. thick, raised 5 cm. off the earth by narrow boards nailed to the edge on the underside. In diagonally opposite corners gaps 15 cm. wide are left between these boards. One of the gaps is closed by a removable plug. From the other, a funnel of fine-meshed chicken wire (the size will depend, of course, on the size of the lizards being taken) extends 40 cm. toward the center of the trap. The inner opening of the funnel is 4 cm. across. The bottom of the trap is covered with the same chicken wire.

During the month of October, 138 lizards were taken in 18 of these traps; one trap accounted for 73 individual lizards. Abundance of reptiles, rather than lack of other available cover, seems to be the factor governing the abundance of take. The trap that has been especially successful is on a small beach on North Chincha Island, off the Peruvian coast. Lizards abound here but, despite an adjacent stone wall, with an abundance of hideaways, the trap continues to take lizards day in and day out. During this period, 20 lizards have been retaken in the traps. The "bait," of course, is shelter from the sun.

Each lizard caught is permanently marked by toe clipping. The order of feet adopted is right front, left front, right rear, left rear. Toes are numbered from the outside in. Thus, a lizard from which is clipped the second toe on the right front feet, first on front left, third on right rear, and fourth on left rear, is permanently marked as Number: 2134.

Temporary marking with Dupont enamel is very satisfactory; the lizards can be identified, with 8x glasses, up to 100 m. Identification by clipped toes must be done within 3 or 4 m. In using the paints, the system described by Mangels (Bird-Banding, IX, 2, April, 1938) for marking birds with colored bands is adapted. Each color (four are in use in the Chincha studies) is assigned an arbitrary number; the order is more easily remembered if the colors are assigned in the order of the spectrum. Red may be 1, yellow 2, green 3, blue 4. Thus, beginning at the head end, the lizard whose toes were cut as described above, would be painted with dabs in the following order: yellow-red-green-blue. The amount of time the colors will last depends to a considerable extent on the lizards' habits; many painted in this study are bright after a month. Males, which spend more time in the open, guarding their territories, than do the females, tend to retain the colors longer.

In taking lizards from the trap, the reverse of the procedure in use by bird-banders is used. A length of stove-pipe, plugged at one end, is placed against the collecting-door, from which the plug has been removed. When the lizards see the dark refuge, they usually dash into it. They can easily be removed from the stove-pipe one by one for marking.

When there are eight or ten lizards in the trap, when it is turned over, they dash frantically about but can be quieted if a hat is dropped onto the wire. They will generally collect under it.

All lizards taken are sexed, when possible, and length recorded — cloaca to snout, measured with dividers. Traps are visited late every afternoon to ensure that no lizards shall pass the night in them.—WILLIAM VOGT, *Casilla 2147, Lima, Peru.*

WHAT IS AN ARTENKREIS?—While not a herpetologist I am an old friend of Dr. Bernhard Rensch, the author of the term Artenkreis, and may thus be permitted to say a few words about an erroneous application of this term in a recent paper on garter snakes by Dr. Henry S. Fitch (1940, Univ. Calif. Publ. Zool., 44: 1–150). Rensch defined the term *Artenkreis* as "a group of geographically representative species or *rassenkreise*" (1929, Das Prinzip geographischer Rassenkreise und das Problem der Artbildung: 100, 101), but never in any of his numerous papers did he apply it to groups of closely related species which co-exist over considerable areas. Furthermore, he emphasized many times that the association of several species in an *artenkreis* did not affect their nomenclature.

As I know Dr. Rensch, he would have separated the eleven forms in question into three species: (1) *ordinoides*, with the subspecies *ordinoides* and *atratus*, (2) *elegans*,

with the subspecies *elegans, biscutatus, vagrans* and *hueyi,* and (3) *couchii,* with the subspecies *couchii, hydrophila, gigas, hammondii* and *digueti.* He would have added that hybrid populations have been observed between *T. elegans biscutata* and *T. couchii hydrophila,* and also between *T. elegans elegans* and *T. ordinoides atratus.* The arrangement adopted by Dr. Fitch, according to which several subspecies of the same Artenkreis occur in the same area, is contrary to all modern practices.—ERNST MAYR, *American Museum of Natural History, New York.*

NOTES ON THE BREEDING HABITS OF *PSEUDACRIS BRACHYPHONA.*—The chorus frog, *Pseudacris brachyphona* (Cope), is one of the most abundant spring frogs to be found in northeastern Kentucky. It is the second frog to appear in the spring, being preceded a few days by the spring peeper, *Hyla crucifer.* The breeding pools of the chorus frog are usually shallow, temporary pools that are well filled with grasses, leaves, and twigs. Temporary pools such as those found in roadside ditches form excellent breeding places for this animal.

Temperature is apparently a major factor in determining the time at which the frogs begin calling. The following table indicates the temperature of both the air and water on five different nights, and whether or not the frogs are calling at that time.

| Date | Temp. of air | Temp. of water | Behavior |
|---|---|---|---|
| February 28 | 6°C | 7.5°C | Calling |
| March 1 | 4°C | 5°C | Not calling |
| March 2 | 4°C | 5°C | Not calling |
| March 3 | 15°C | 12°C | Many calling |
| March 6 | 5°C | 7.5°C | Calling |

The frogs observed did not call when the temperature of the air was below 5° C and the temperature of the water below 7.5° C. As the temperature of the water and air became higher, the number of calling frogs increased.

The writers are at variance with Green (COPEIA, 1938: 79–82), who reported that the males "line the edges of the pools, stationing themselves either in or out of the water." The writers found that the males were usually well distributed throughout the pools. At night they made no effort to conceal themselves as did *Hyla crucifer.* However, the least disturbance in the day would send them frantically to the bottom of the pond, where they hurriedly concealed themselves.

On March 8, two copulating pairs were collected, and eggs were found for the first time. Previous to this date random collecting throughout the pools revealed only males. Apparently the males preceded the females to the ponds by about eight days. After the females arrived at the ponds, many frogs were sexed, and it was noted that males far outnumbered the females.

Sex recognition is doubtless by a combination of factors, apparently one of the more important of which is the quietness of the frog clasped. Several times males were observed to clasp males, only to have them struggle and cry out. In no instance did a clasped female either struggle or cry out. Amplexus is axillary, and while in amplexus both frogs remain partially submerged.

In order to determine the number of eggs laid by each female, ten average-sized individuals were dissected. The largest number of eggs found in any one of these was 1202, and the smallest number was 983. The average number found in the ten females was 1092 eggs.

The eggs were deposited in masses attached to a stem or leaf. The number of eggs found in each of eleven such masses was counted, and the number found to vary from 28 to 40, the average being 34 per mass.

In the laboratory at temperatures varying from 18 to 22 degrees, hatching occurred from 72 to 96 hours after the eggs were laid. In the pools, however, where the temperature ranged from 2 to 13 degrees, hatching did not occur for a week or ten days.

Several tadpoles kept in a large aquarium in the laboratory at room temperature metamorphosed from forty to fifty days after hatching. Tadpoles in outdoor pools metamorphosed in forty-five to fifty-five days.—ROGER W. BARBOUR and ELMON P. WALTERS, *State Teachers College, Morehead, Kentucky.*

# Ichthyological Notes

ON A HEAVY RUN OF DOLPHIN, *CORYPHAENA HIPPURUS*, OFF THE TEXAS COAST.—During six days in 1939, from May 25 to May 30, inclusive, there occurred a heavy run of dolphin (*Coryphaena hippurus*) at Freeport, Texas, when eleven sport fishing craft took, in all, 1,430 specimens.

In addition, two boats operating around the mouth of the jetties at Galveston reported heavy catches of dolphin.

The fish taken at Freeport on the 27th, 28th and 29th were from the Thirty Two Mile Banks, a coral formation occurring in about 20 fathoms of water and were thickly concentrated around an old tree trunk. The water being very clear, it was quite possible to see them, and to gain, from actual sight, some perception of their great numbers. As far down as it was possible for vision to penetrate the water, and in as great a radius as the eye could compass in this refractory medium, the water was filled with the brilliant, electric blue flashes which were reflected in irridescent beams from the fins and tails of the fishes as they moved. It was a magnificent and beautiful sight.

The radius of distribution in relation to the log was probably 100 yards. Once that limit was passed they rapidly became scarcer, and at 200 yards from the log it was almost impossible to get a strike. These fish were from 12 inches to 24 inches in length, and were intermixed with small bluefish.

The dolphins' habit of following driftwood is one of their most marked characteristics, and during the time of their appearance in these waters it is almost a certainty that any such flotsam is a sure signal for a large catch, so much so that a lookout is kept as assiduously for some such object as it is for the buoys which mark the fishing banks. Once found, the log or other drift is sometimes secured to the boat. When this is done it is possible to take most of the members of an entire school, as they are not in the least alarmed by the proximity of the vessel, or by the commotion made by the fishermen.

Very often in lieu of logs, stumps, or other drift wood, they will make use of patches of the Gulf weed, which at times is quite thick, the water being dotted with it in clumps of from a foot to a yard in diameter. A cast at the edge of the weed will often be rewarded with a strike, and as many as three or four fish may be taken from the same place. When associated with the weed the school is apt to be more widely scattered, a few fish being associated with each clump of the floating vegetation, instead of being heavily concentrated as they usually are about the drift wood. They are not (in so far as I know) a very solitary fish, and it is not often that one finds one or two dolphin detached from an aggregation.

They seem to have a very marked gregarious instinct; so much so that it is quite possible to keep the school around the boat by leaving one or two of the hooked fish in the water, and towing them behind the boat. The rest of the school will follow almost like a flock of sheep and do not seem to be in the least disturbed by the wash of the screw, or the constant hooking of other fish. If anything they only become more excited after each capture and follow more closely after the boat.

These small fish are excellent eating. The flesh is white, delicate, and of good flavor, although somewhat dry. Properly cooked, they are very palatable, and are much to be preferred to kingfish or bonito, and do not suffer in comparison with Spanish mackerel or red snapper. However, because their capture is relatively expensive, they are not so well known to many anglers, and because they are migratory, and not so numerous as such fish as Spanish mackerel or snapper, they have not at any time supported a commercial fishery.—J. L. BAUGHMAN, *311 Peden Ave., Houston, Texas.*

RECORD OF *ARCTOZENUS CORUSCANS* (JORDAN AND GILBERT) FROM PUGET SOUND.—A specimen of *Arctozenus coruscans*, 228 mm. in standard length, was taken near Tacoma, Washington, in Puget Sound, November 21, 1939, by Mr. W. Jordan and sent to the School of Fisheries, University of Washington, Seattle. This is the second known specimen of this species ever to be collected. The type specimen, now in the U. S. National Museum, was collected in 1880 near Port Townsend, Washington.

The specimen taken near Tacoma is very similar to the descriptions given by Jordan

and Gilbert (Proc. U. S. Nat. Mus. 3, 1880: 411–413) and Jordan and Evermann (Bull. U. S. Nat. Mus., 47, 1896–1900) with the following additions and exceptions: The scale rows along the body are about 160. (The scales were rather difficult to count because the rows are somewhat irregular, the scales deciduous and the specimen was slightly damaged.) Jordan and Gilbert (1880) note 60 scales in the lateral line; however, the lateral line does not run the full length of the body but ends at about the middle of the anal fin base. This is illustrated in Figure 259, Plate XCVI of Jordan and Evermann (1900). Further, the figure indicates that the number of scale rows are about 160 in the type specimen. On the other hand, the figure errs in that it lacks an adipose fin, although it is mentioned in the description, and fails to show scales on the head as is indicated in the specimen at hand. No scales on the head were mentioned for the type specimen. These scales cover the upper half of the opercle, the preopercle, the area below the eye, and part of the snout. The upper half of the opercle is sculptured with wavy, radiating ridges.

Two rows of minute teeth run parallel on the long slender tongue of the Tacoma specimen. Teeth in the lower jaw are of two types: one type is large, depressible, set at intervals along the posterior three-fifths of the lower jaw; the other type consists of small teeth, each tooth set close to and just in front of a large tooth. All teeth become slightly smaller anteriorly. There are numerous small teeth on the palatines.

There are 6 branchiostegals and 8 ventral fin rays, as contrasted with 7 branchiostegals and 9 ventral fin rays in the type. The double series of minute "phosphorescent organs" on the mandible, noted by Jordan and Gilbert, are merely pores opening into the mandibular canal.

TABLE OF MEASUREMENTS AND COUNTS

Total Length .....243.0 mm.
Standard Length .....228.0 mm.

| Character | In 100ths of Standard Length |
|---|---|
| Head Length | 23.90 |
| Interorbital Width | 2.41 |
| Depth of Body | 10.09 |
| Length of Mandible | 11.62 |
| Length of Maxillary | 9.21 |
| Largest Diameter of Eye | 3.51 |
| Snout to Eye | 11.40 |
| Snout to Nostril | 9.21 |
| Snout to Dorsal Fin | 66.22 |
| Snout to Adipose Fin | 95.16 |
| Snout to Anal Fin | 82.44 |
| Snout to Ventral Fin | 70.16 |
| Snout to Pectoral Fin | 24.56 |
| Depth of Caudal Peduncle | 1.97 |
| Length of Dorsal Fin Base | 3.07 |
| Length of Anal Fin Base | 15.35 |
| Length of Pectoral Fin | 7.67 |
| Length of Ventral Fin | 3.95 |
| Length of Adipose Fin | 3.51 |
| Number of Dorsal Fin Rays | 9 |
| Number of Anal Fin Rays | 32 |
| Number of Ventral Fin Rays | 8 |
| Number of Pectoral Fin Rays | 11 |
| Number of Branchiostegals | 6 |
| Scale Rows along body | 160 (ca.) |

—ARTHUR D. WELANDER, *University of Washington, School of Fisheries, Seattle, Washington.*

LETHAL EFFECT OF THE COLD WINTER OF 1939–40 ON MARINE FISHES AT KEY WEST, FLORIDA.—The winter of 1939–40 was one of the coldest winters at Key West, Florida, in the past 40 years, if not the coldest. The Key West Weather Station recorded a mean temperature of 65.4 degrees for January, 1940; the mean maximum recorded was 71.3, the mean minimum 59.4; the lowest record for the winter was 43 degrees on January 28.

On January 21 the officially recorded temperature of the sea water at the submarine base was 67 degrees. This decreased steadily to 57 degrees on January 28. We visited the yacht basin and north shores on January 26 and 27, and found no fish benumbed, although a dozen small ones were stranded on tide rocks.

On the afternoon of the 28th a friend came saying, "The fish are all along the beach; the big ones are mostly picked up by now, but there are thousands of little ones." Accordingly, at the north shore of Trumbo and the yacht basin that afternoon and the next morning, we collected or observed the species listed below. Many of these were to be mounted; and with so much material to be taken care of we were, unfortunately, unable to run the south shores of this and the adjoining keys, which have a somewhat different fauna. Also, we much regret not having combed the north shores earlier in the day, before the local people had gathered the larger edible species.

Species observed were as follows; those where the number is not mentioned were plentiful, though not necessarily the most abundant:

Herring and anchovies (few, unidentified); *Strongylura raphidoma; Chriodorus atherinoides* (1); *Hemirhamphus brasiliensis* (few); *Hippocampus punctulatus?* (1); *Hippocampus* sp. (1); *Mugil trichodon; Sphyraena barracuda; Caranx chrysos; Mycteroperca bonaci* (1); *Promicrops itaiara* (3 ft.); *Ephinephalus striatus; Diplectrum formosum,* (few); *Lutianus griseus, L. apodus, L. analis, L. synagris* (these, and the following grunts, were everywhere in great numbers); *Ocyurus chrysurus; Bathystoma striatum, B. rimator, Haemulon macrostomum* and *H. albium* probably all present but not distinguished as to species; *Haemulon flavolineatum, H. plumieri, H. parra; Anistotremus virginicus* (2); *Eques acuminatus* (1); *Gerres cinereus; Abudefduf saxatilis* (few); *Cryptotomus ustus; Sparisoma flavescens?; Pseudoscarus guacamaia* (1, 27 inches); *Scarus caeruleus* (few); *Scarus* sp. (50 or more); *Pomacanthus arcuatus; Angelichthys ciliaris* (2); *A. isabelita* (1); *Acanthurus caeruleus* (2); *Monocanthus ciliatus,* many young of this and of *Stephanolepis hispidus; Lactophrys bicaudalis* (5); *L. tricornus* (hundreds in small sizes); *Spheroides spengleri; Diodon hystrix* (1 on Bahia Honda); *Scorpaena* sp. (few); *Chilomycterus atinga* (1); *Syacium micrurum* (2); *Antennarius ocellatus* (2 adult); one octopus, no other invertebrates.

It is noteworthy that during these north shore observations no sharks or rays were observed; and no gobies, blennies, batfish, pipefish, *Opsanus,* and no demoiselles except the few *Abudefduf,* although all these are frequent or abundant in the south shore waters.

On Charlotte Harbor shores three weeks later we noted the remains of many large *Tarpon atlanticus, Centropomis undecimalis, Lachnolaimus maximus, Promicrops itaiara, Caranx hippos,* and *Galeichthys milberti.* We were told the local fish house had handled 40 tons of benumbed fish, including many large snook and hogfish; while great numbers were buried for sanitary reasons at Punta Gorda, where the atmospheric temperature fell to 26 degrees. A manatee, estimated at 600 lbs., succumbed in Peace River at Cleveland and was left stranded by the tide. *Caranx hippos* was reported in great numbers at Bradenton.—J. C. GALLOWAY, *Port Allegany, Pennsylvania.*

NOTES ON VARIATION IN *SCORPAENA PLUMIERI* BLOCH.— The writer recently examined eighteen specimens of this fish from Florida, Bermuda, Puerto Rico, Jamaica, Panama, Venezuela and Brazil. Head armature, pits, spines and stays are very constant. Head and body proportions are rather constant, except that some fish are more slim than others. Certain important variations were noted that have never been pointed out or emphasized before.

SPINES AND RAYS.—Metzelaar (Over Tropisch Atlantische Visschen, 1919) examined a specimen having only eleven dorsal spines instead of the twelve characteristic of the genus *Scorpaena.* Fishes of the family Scorpaenidae in the Western Hemisphere are characterized by three anal spines. Specimen 19817, Field Museum of Natural History, collected in Panama by Meek and Hildebrand, has four anal spines. The first two are short. The first seems to be superflous, while the last three are homologues of the three ordinarily present in the scorpaenids. In this species the anal fin count is III, 5 with the last ray often split. A fish from Key West, Florida, No. 16155, Field Museum of Natural History, was found to have an anal count of III, 6, with the last ray split, giving the appearance of seven rays.

FLAPS, TABS AND TENTACLES.—The most striking variation in this species concerns the cutaneous flaps of the body and the head and the tentacles of the head. In some individuals they are so numerous that the fish has a shaggy appearance, while in others they may be almost completely absent, so that compared to its companions the fish appears to be bald. Skin flaps are always more prevalent above the lateral line than below. On the line itself they are enlarged and they are particularly thick on the head. Bald specimens have no supraocular tentacles at all. The only flaps invariably present are the short supranasals over the anterior nostrils, membranaceous flaps on the chin and preopercle and a few flaps on the lateral line. This situation seems not to be recognized by some workers and some of them have followed Jordan and Evermann (Fishes of North and Middle America) in erroneously using a comparison of length of the supraocular tentacle with that of the eye to separate the species, under the supposition

that the tentacle is longer than the eye. This is not always true where the tentacles are present and in some specimens they are completely absent. In the fish examined, whenever the posterior supraocular tentacles were present the smaller anterior pair was also present. When one pair was absent so was the other. Metzelaar (*op. cit.*) has previously called attention to the extreme variation of tabs and tentacles in the *Scorpaena*. Tentacles and flaps may also vary widely in appearance, being wide, curled and lacianate on some fishes, while on others they are thick, pennant-shaped and unbranched. No locality variation was manifest, nor was there one for size. However, these questions, as well as that of a possible sex variation, have not been answered.

In most works the gill-rakers of *S. plumieri* are said to number nine on the lower gill-bar and four on the upper bar. Beebe and Tee-Van (Field Book of the Shore Fishes of Bermuda, 1933) give seven for the lower bar. The gill rakers are very difficult to count without dissection, which was not done, and I have counted those of only two fish from Bermuda with surety. In one the count for the outer gill was 11 plus 5 and in the other 10 plus 4. This figure includes the raker at the angle with those of the lower bar. The anterior rakers are very small and have possibly been overlooked or possibly some workers have considered them mere stubs and have not counted them at all. The rakers are largest at the angle of the gill-bar, being rather long there, contrary to the statement of Jordan and Evermann (*op. cit.*) that they are as wide as long.

The color variation in live fish has been described by Jordan and Evermann and others. The pattern itself is very constant, the colors varying. In alcohol, base colors vary from sandy to nut brown and dark khaki. Panama fish were all dark, tarry brown running almost to black in places.

A fish from Natal, Brazil, had huge posterior nares. It did not differ from other specimens in other respects, except that possibly it was a little more rugose.

The genus *Pontinus* is separated from *Scorpaena* chiefly by the fact that in fishes of this group none of the pectoral rays are branched, while in *Scorpaena* they are. I have examined three juvenile specimens of *S. plumieri* or a closely related species and find that all pectoral rays are unbranched; so it must be understood that the above distinction only applies to post-juvenile and adult specimens of *Scorpaena*. Among adult *S. plumieri* large fish had a greater number of branched pectoral rays than small specimens, indicating that the number of rays branched increases with growth of the fish. —Gordon Gunter, *Game, Fish and Oyster Commission, Rockport, Texas.*

# Reviews and Comments

THE FISHES OF AUSTRALIA. PART I. SHARKS, ETC. By G. P. Whitley. Royal Zoological Society of New South Wales, Sydney, 1940: 1–274, 299 figs., 7/6 (about $1.60).—This is the first volume of a projected work on the fishes of Australia, which aims "at giving a short description and an illustration of about two thousand distinct species, too many for a single handbook." The scope of this volume includes the sharks, rays, lungfish, lancelets and lampreys, with an account of *Latimeria* thrown in for good measure. All known species of these groups are included. Each is figured, and for each there is a very short description and account of the range, and as extensive an account of the biology as knowledge permits. There are no keys. This is a book which scientists will probably treat with condescension, if not contempt, for it is not a critical work and contributes little, if anything, to our knowledge of Australasian fishes. I suspect, however, that the author does not care very much about what other scientists may think, but is more concerned about the Australian layman's opinion, and his book is the kind of work that a layman cherishes dearly. The natural history lore, the discussion on the place of sharks in South Sea Island mythology, and the stories of shark attacks on man, are very absorbing indeed.—Lionel A. Walford, *Fish and Wildlife Service, Stanford University, California.*

O. C. MARSH, PIONEER IN PALEONTOLOGY. By Charles Schuchert and Clara Mae LeVene. Yale University Press, New Haven, 1940. xxii + 541 pp., 30 pls., 33 figs., and frontispiece.—Today every child knows what dinosaurs looked like, and the names *Brontosaurus, Stegosaurus,* and *Triceratops* are likely to be in the vocabulary of any well-educated person. It is now a little hard to realize that this information was not always with us, and that popular knowledge of these great fossil reptiles in their complete form is due in great part to the researches of one man.

In any selection of the nineteenth century giants of American natural history, Othniel Charles Marsh must take his place among such men as Say, Audubon, Dana, Agassiz, Gray, Leidy, Baird, Cope and Gill. Endowed with a keen and aggressive mind, a true collector's instinct, and great monetary wealth, trained at Yale and Berlin under such masters of geology and zoology as J. D. Dana, H. E. Beyrich, Wilhelm Peters [1] and C. G. Ehrenberg, and presented with a research professorship in a fine new museum given to Yale by his uncle, George Peabody, Marsh was in an excellent position to indulge his developing interest in vertebrate paleontology. And he made full use of his opportunity. He organized and led many expeditions into the western fossil regions, employed corps of collectors, preparators, illustrators and scientific assistants, described new acquisitions promptly and accurately, and had always in mind the necessity of epitomizing his discoveries and treating them monographically. His great monographs on the Odontornithes or toothed birds, the Dinocerata or Uintatheres, and the Dinosauria, his unravelling of the phylogeny of the horse and the description of its ultimate ancestor, *Eohippus,* and the unrivalled vertebrate fossil collection he amassed at the Peabody Museum, made his laboratory a mecca for naturalists from Europe as well as America and earned for him the highest of scientific honors. Huxley derived much for his lectures and essays from Marsh and Darwin expressed a desire to go to America solely to see "Marsh's Museum."

Schuchert and LeVene's biography is an excellent treatment of the life of a great man, in view of its subject it is impossible to avoid comparing it with Osborn's biography of Marsh's great paleontological rival, Cope. The books are nearly as different as were their subjects, and the Osborn biography suffers by comparison. Possibly this is because a greater amount of personal material on Cope was available, and possibly it is because a really adequate treatment of Cope's life and his multifarious interests could not be given short of two or three volumes. Marsh confined himself strictly to paleontology and even there his contributions were in a narrower field than Cope's. But he was far more methodical than Cope and served up his productions in a much more palatable form. At any rate, Schuchert and LeVene are duly critical of Marsh. He was undoubtedly somewhat egotistical, pompous and self-righteous. He employed able assistants to do much of his routine work and generally refused them permission to publish while in his employ. These characteristics and acts enraged Cope just as Cope's brilliant but often careless papers, his belligerence and his frequently unorthodox method of doing things irked Marsh. The result was one of the most unfortunate yet inevitable public feuds ever to deface the annals of science. The last living colleagues of both men have now given their final pronouncements, and it is hoped that the swiftly cooling embers will never again smoulder.

Those who are interested in the development of natural history in America will be grateful to the authors for this book. It fills one of the few remaining gaps in the biographical history of America's great naturalists.—GEORGE S. MYERS, *Stanford University, California.*

THE COD FISHERIES. THE HISTORY OF AN INTERNATIONAL ECONOMY. By Harold A. Innis. Yale University Press, New Haven; the Ryerson Press, Toronto, 1940: i–xviii, 1–508, 7 maps, $3.50.—An account of the influence of the cod fisheries on the history of North America is a difficult and tremendous task, as one will realize on reading Professor Innis' book. Of all the resources of North America that attracted the nations of Europe to exploration and settlement in the Western Hemisphere, the cod resource was perhaps the most important in the beginning. Professor Innis gives the

[1] Wilhelm Karl Hartwig Peters (1815–1883) was probably the greatest German vertebrate systematist. He is remembered through numerous excellent papers on mammals, reptiles, amphibians and fishes, especially the Chiroptera and caecilians, and the extensive reports on his personal exploration of Mozambique. The only portrait of Peters ever seen by the reviewer is that on plate 6 of "O. C. Marsh."

history of the French, Spanish, Portuguese, English, and American fisheries in considerable detail, placing the main emphasis on those of British North America. Though the book is of inestimable value as a reference work and as a depository of a great quantity of important historical information which would be very difficult to locate in original sources, it does not make very absorbing reading; and it does not leave the reader with a very coherent conception of the effect of the cod fisheries on the course of history. This may be not the author's fault, but the fault of the fact that the cod fisheries have concerned a number of countries in a number of ways, and have, in turn, been influenced by a complexity of events. It would have added considerably to the interest of the book if there had been a chapter about the influence of the fisheries on the history of the cod.—LIONEL A. WALFORD, *Fish and Wildlife Service, Stanford University, California.*

THE INVERTEBRATES. PROTOZOA THROUGH CTENOPHORA. By Libbie Henrietta Hyman. McGraw-Hill, New York, 1940: i–xii, 1–696, 221 figs., $7.00.—People trained primarily in Ichthyology frequently must concern themselves with invertebrates, whether to identify them, to study their biology, or to consider them in relation to the biology of fishes. For these people, a guide to the study of Invertebrate Zoology which is not a mere college text is an important desideratum. There has been, for American workers, no such guide, and it is with pleasure that we recommend Dr. Hyman's book as fulfilling this need. Although the book emphasizes the morphology, physiology, embryology, and biology of the invertebrates, and gives but slight attention to classification, phylogeny, and palaeontology, yet one can easily, by this book, determine the orders of the groups considered, and, thanks to an extensive and good bibliography at the end of each chapter, can be guided to the right places for more complete identification. This volume includes Protozoa, Porifera, Cnidaria (Coelenterata), and Ctenophora. Dr. Hyman concludes her preface to this work with the following remark, "Whether I shall proceed with this treatise will depend upon the reception accorded the present volume." Please, Dr. Hyman, proceed.—LIONEL A. WALFORD, *Fish and Wildlife Service, Stanford University, California.*

ATLAS OF OUTLINE DRAWINGS OF THE DOGFISH SHARK, THE NECTURUS, AND THE CAT FOR VERTEBRATE ANATOMY. By Samuel Eddy, Clarence P. Oliver and John P. Turner. John Wiley & Sons, Inc., New York, 1940: figs. 1–77. $1.50.—This series of excellently drawn anatomical outlines accompanies the 100-page *Guide to the Study of the Anatomy of the Shark, the Necturus, and the Cat,* which was written by the same authors and published by Wiley at $1.50 in 1939. Both works are provided with ring binders and otherwise prepared for pedagogic convenience. They are excellently designed to fill the needs of a semi-predigested course in comparative anatomy, which many teachers believe to be required for the sake of efficiency and saving of time. Maybe so.—CARL L. HUBBS, *University of Michigan, Ann Arbor, Michigan.*

WHERE IS THE ——— COLLECTION? AN ACCOUNT OF THE VARIOUS NATURAL HISTORY COLLECTIONS WHICH HAVE COME UNDER THE NOTICE OF THE COMPILER. By Charles Davies Sherborn. Cambridge University Press, Cambridge, England (The MacMillan Co., N. Y.), June 11, 1940: 1–149. 90 cents.—This is designed as a handbook for systematists who wish to know the present status and depository of various natural history collections, most of them originally private. The author disarms critics by stating flatly that the book is not exhaustive. He is correct. The list is exceedingly incomplete, both in entries and in the data on certain collections mentioned. But it is a start on a very useful project, and since every other page is left blank for annotations, it may be hoped that collaboration of users will in time produce an exceedingly valuable compilation.—GEORGE S. MYERS, *Stanford University, California.*

A BIOGEOGRAPHICAL STUDY OF THE *ORDINOIDES* ARTENKREIS OF GARTER SNAKES (GENUS *THAMNOPHIS*). By Henry S. Fitch. Univ. California Publ. Zool., 44 (1): 1–150, pls. 1–7. University of California Press, Berkeley, 1940. $1.50.—This important paper, submitted over three years ago but only recently published, revises the west American garter snakes of the *ordinoides* complex. It forms still another of the extensive and painstaking studies which are currently shedding so much

light on the classification of North American reptiles. *Thamnophis* is a notably difficult genus and the western forms clustering about *ordinoides* have never received adequate treatment in spite of two revisions (Ruthven, 1908; Van Denburgh and Slevin, 1918) and Van Denburgh's monograph of 1922.

The reviewer approaches an evaluation of Dr. Fitch's paper from the viewpoint of a herpetologist who has little special knowledge of *Thamnophis* systematics, but who lives in the midst of the *ordinoides* complex and has perforce frequently to identify specimens of these ubiquitous snakes. His review must therefore be taken more as the thoughts of one interested in the general theory and practice of taxonomy than as the opinion of a person competent to criticize Dr. Fitch's actual systematic results.

The paper is impressive in its care of execution, completeness and physical bulk. In it we see again the guiding hand of that master taxonomist, the late Joseph Grinnell. The reviewer appreciates and commends Dr. Fitch's support of the definable criterion of discontinuity, rather than that of degree of difference, in distinguishing as separate categories those real but inherently incomparable populations which we must call species and subspecies, and heartily approves the corollary—a rejection of the intrinsic indefinity of the *Rassenkreis* system of Rensch and other Germanic taxonomists. Why Dr. Fitch has adopted the foreign term *Artenkreis* is therefore not at all clear. After all, he is writing in the English language and although the German word may express the intended idea with some degree of precision, its use is neither necessary nor in good taste. Nor is it evident to the reviewer just why the paper is labeled "a biogeographical study"; it is essentially a study of natural animal populations (= pure zoological systematics), and its zoogeographical conclusions must by definition (and actual content of the paper) be considered a by-product of the main work.

While the above criticisms may be somewhat academic, the reviewer does see a serious fault in the paper. In these days of expanding museum collections, the very abundance of material frequently hampers the taxonomist. It is sometimes an exceedingly difficult mental task to handle and comprehend the characters of several hundreds or thousands of specimens, especially when those characters are largely meristic in character. Ichthyologists, more especially those who have dealt with the races of fishes, discovered a long time ago that the adoption of modern quantitative methods of handling their data was absolutely necessary. Ornithologists and mammalogists, having fewer discrete characters to handle, have not yet awakened, and the herpetologists, who above all would find statistical methods of enormous help, have been more or less under the influence of the students of the higher vertebrates. Dr. Fitch's paper, on a group which seems to have been especially created for statistical treatment, appears to be utterly innocent of any modern quantitative methods, unless one can include ordinary graphic representation of raw data under that category. Its consequent loss of clarity and conciseness, though perhaps invisible to the "old line" systematist, is great. Possibly correlated is the entire absence of a systematic key, an omission which the reviewer considers a heinous sin and an act of disservice to the author's herpetological colleagues, who are forced to search laboriously through a hundred and fifty pages of text (without even the aid of frequency graphs) to identify their material. It can be understood that Dr. Fitch may have found the compilation of a key extremely difficult from the very nature of his material and treatment, and the reviewer is perfectly aware that "key characters" have often actually retarded the understanding of natural populations. But provision for specimen identification is still one of the necessary by-products of pure systematics, as well as a much appreciated courtesy to one's fellow workers, and the compilation of a key to the *ordinoides* complex would have been made easier by simple statistical analyses of meristic characters. As an example we may mention Miss Storey's recent revision of the West Indian herrings of the difficult genus *Harengula*, none of the species of which were invariably definable on any one character. But upon statistical analysis her material became separable into what appear to be actual specific groups, and a key was made which, if followed through all its steps, will successively sift out specimens into their proper categories. Naturally, only biological knowledge and judgment can say whether such categories are natural populations. Statistics cannot think for the biologist, but they can make clear and understandable many things which otherwise baffle him.—GEORGE S. MYERS, *Stanford University, California.*

# EDITORIAL NOTES AND NEWS

**Biological Abstracts**

DURING 1940, 605 contributions to the increasingly popular field of bioclimatology were summarized in *Biological Abstracts*. The *Bioclimatology-Biometerology* section proper reported 234 contributions that had appeared in 127 current periodicals and reviewed 31 books. References to climate and weather effects on human physiology, animal and plant behavior were reported in 340 abstracts in other sections of *Biological Abstracts*, and their subject matter was outlined, month by month, at the beginning of the *Bioclimatology-Biometerology* section.

**Annual Meetings**

THE TEXAS HERPETOLOGICAL SOCIETY, under the presidency of DR. C. S. SMITH of the Southwest Texas State Teachers College, held the Third Annual Field Meet on April 19–20, at Sealy, Texas, in the region of the new Stephen F. Austin State Park, with an attendance of thirty-five. Honored guests were KARL P. SCHMIDT, of the Field Museum of Natural History, his son JOHN, and C. M. BARBER, of Hot Springs, Arkansas. The activities included field collecting during Saturday and Sunday morning, and a barbecue dinner Saturday night followed by a campfire discussion and an informal talk by MR. SCHMIDT on his experiences collecting crocodiles and on his recent trip to Peru. Officers elected for the new year are: President, DR. LEO T. MURRAY, of the Strecker Museum, Baylor University, Waco; Vice-President, JACK DAVENPORT, of the Witte Memorial Museum, San Antonio; Secretary-Treasurer, OTTYS SANDERS, of the Southwestern Biological Supply Co., Dallas. The Fourth Annual Field Meet will be held during the spring of 1942, and a cordial invitation is extended to all herpetologists to attend.

The detailed account of the twenty-fourth annual meeting of the Society, held at Gainesville, Florida, April 3–5, will appear in the next issue of COPEIA.

**News Notes**

DR. ALBERT W. C. T. HERRE returned to Stanford University in April after an eleven-months' expedition in Asia. He brought large ichthyological and herpetological collections from the Philippines, the Malay Peninsula, Lower Burma, Bengal, the Central Provinces, and the southern Indian Peninsula.

DR. NORMAN HARTWEG, a member of the Museum of Zoology, University of Michigan expedition to Chipas, returned in May.

DR. HENRY S. FITCH, formerly with the San Joaquin Experimental Range, O'Neals, California, is now in the United States Army at the 26th Station Hospital, Camp Luis Obispo, California.

MISS MARGARET H. STOREY has been appointed to the position of Assistant Curator of Zoological Collections in the Natural History Museum of Stanford University.

Word has been received from SR. CARLOS A. LIZER Y TRELLES announcing the death of DR. FERNANDO LAHILLE in the middle of 1940, at the age of 80.

KARL P. SCHMIDT, Chief Curator of Zoology, Field Museum of Natural History, Chicago, has been appointed Editor of the section *Amphibia* in *Biological Abstracts*. Mr. Schmidt's appointment fills the vacancy made by Dr. G. K. Noble's death.

**Correction**

THE editors regret that in COPEIA, 1, 1940, an unfortunate shift in manuscript pages occurred in the two articles by Paul Chabanaud, pages 30–32. On page 32, that portion of the second article following line 16, and including footnote 3, should be transposed with the remainder of the first article beginning with "p" in the middle of line 6, on page 31.

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